DESIGN Issue
Product Engineering
each wheel its own driver . . . see page 5

IT'S ICE-SLICK

Won't Stick at 30° Below

Try C/R K-400 Cups for Smoother Power Cycles

Any time you face the problem of reducing cylinder cup breakaway or sliding friction, chattering or freezing, come see us. We're reasonably certain that Chicago Rawhide's Sirvis Leather K-400 cups can help you. Their specialty is easy sliding — particularly in vacuum cylinders at sub-zero temperatures and in pneumatic cylinders at ambient temperatures and low pressures. Tests show a 50% reduction in breakaway and sliding friction over standard leather cups at ambient temperatures . . . and these K-400 cups are functioning beautifully in applications at -30° F. In another test, C/R Sirvis K-400 cups were run well over one million cycles at 20" of vacuum with negligible leakage and wear.

So if you are trying to design a new, smooth-working, low-friction pneumatic cylinder — or take the bugs out of an old one — jot down C/R K-400 cups and call us.

CHICAGO RAWHIDE MANUFACTURING COMPANY

SIRVIS DIVISION, 1203 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Offices in 55 principal cities. See your telephone book.

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario

Export Sales: Geon International Corp., Great Neck, New York

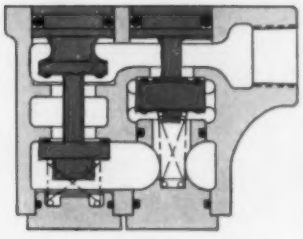
C/R PRODUCTS: C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • C/R Non-metallic gears

C/R

CIRCLE NO. 201 READER SERVICE CARD

a basic **Ross** *valve building block*

4-way inline mounted valve body



- **Compact—saves space**
- **Ross quality**
- **Costs much less than base mounted 4-way**

Lots of designers use this valve where they must save space. It was designed specifically for compactness! Others use it to save money *without sacrificing* quality—when J.I.C. allows the usage of an inline valve, it meets J.I.C. specs. It's a unit of the Ross Skyline series which features modular construction, so it can be actuated with any Skyline series head. Ross poppet construction means pressure assists the seal, and short poppet travel gives faster response. On most applications it outlives the machine—and frequently doesn't even require maintenance. Write for Bulletin 321.

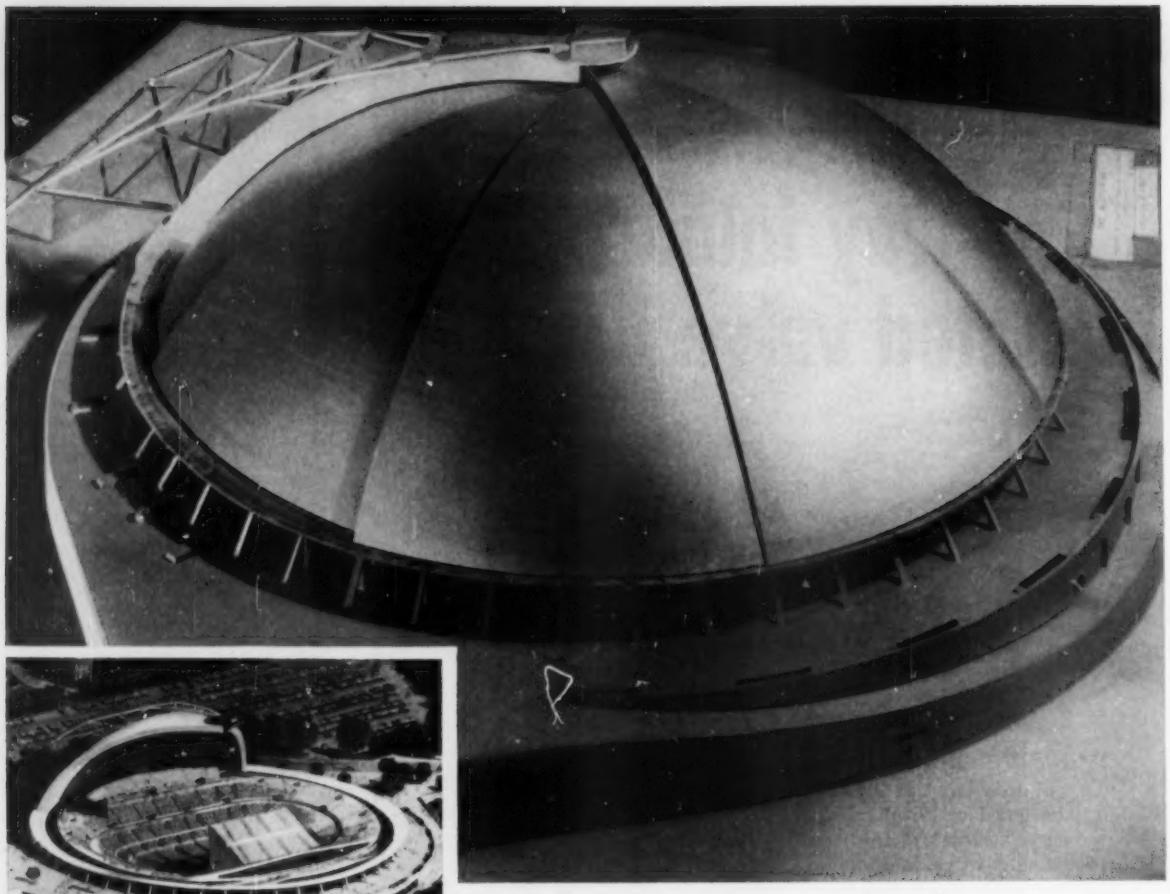
* WHITEMODEL SPOOL SOLENOID | * GOLDMODEL OIL-IMMERSED SOLENOID | * SILVERMODEL JIC SPOOL SOLENOID | GREENMODEL DOUBLE SOLENOID MOMENTARY | BLUEMODEL AIR OPERATED | BLUEMODEL AIR-OPERATED MOMENTARY ADAPTOR | BLUEMODEL AIR-OPERATED TIMED IN | BLUEMODEL AIR-OPERATED TIMED-OUT | *THIS AIR INDEX ADAPTOR CONVERTS THESE HEADS TO MOMENTARY ACTION

"every head meets every body at this gasket"

ALL SKYLINE HEADS AND BODIES ARE BUILDING BLOCKS TO GIVE YOU MANY VALVES FROM A FEW HEADS AND BODIES

Ross **OPERATING VALVE COMPANY**

114 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.



All-weather auditorium in Pittsburgh will be covered by a 415-foot diameter Nickel-containing stainless steel dome. Largest of its kind in the world, the dome will protect an audience of more than 13,000.

"Push-button umbrella roof" of stainless steel gives Pittsburgh a new all-weather auditorium

Watching a play or listening to music under the stars heightens the enjoyment. That is, until a passing shower comes along to wash out the fun. But now comes a new idea in auditoriums. In this one, an umbrella roof of Nickel-containing stainless steel will close at the first drops of rain—and on with the show.

It's a simple concept, but a daring one. Eight huge sections nest together when the dome is open. Push a button, and six of these sections glide quietly together around an outside track.

They looked into all sorts of sheathing materials in designing the dome before choosing stainless – a Nickel-containing stainless steel.

For stainless with Nickel in it is one of the most weatherproof metals there is. It is corrosion-resisting all the way through – in salt air as well as industrial atmospheres. What's more, it's virtually self-cleaning – rainfall alone keeps this metal clean.

No wonder you see Nickel-containing stainless wherever strength, long life and handsome appearance are called for! Not only in buildings – inside and out – but everywhere you look.

Suggest something to you? Can stainless help you solve a problem involving corrosion, stress, appearance, temperature extremes? The way to find out is to write us. We'll see if Nickel-containing stainless steel – or some other nickel alloy – may be just what you're looking for.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

DESIGN issue

September 14, 1959 Vol. 30, No. 37

DEPARTMENTS:

INTERESTING TO NOTE 5
DEVELOPMENTS TO WATCH 35
THE ENGINEERING WEEK 37
COMING EVENTS 42
HORIZONS 65
PRODUCT DESIGNS 75
SIGNIFICANT COMPONENTS 97
CATOLOGS AND BULLETINS 111
CURRENT REPRINTS 128
TANGENTS 136
DESIGN ABSTRACTS 149
NEW BOOKS 153
ADVERTISERS INDEX 167
READER SERVICE CARDS 171

FEATURED:

EQUIPMENT SAYS IT IN COLOR . . . *J L Seminara*
This eye-catching code conveys information from machine to operator 67

NEW DATA FOR HIGH-PRESSURE AIR . . . *T H Chadwick and P L Brady*
Here are curves useful from 0 to 12000 psi and –150 to 250 F 71

HOW BALLBEARINGS WILL PERFORM . . . *B L Mims, The Barden Corp*
Roundup of devices that check for torque, vibration, runout. 78

PAINLESS DRAWING CHANGES . . *J W Born, Iron Fireman Mfg Co*
A special-service group keeps drawings up to date 83

MEASURING RESIDUAL STRESSES IN GEARS . . . *E T Bergquist and S M Lenhoff*
Shortcut method evaluates effects of material and heat treatment 84

13 HANDLES FOR INSTRUMENTS . . . *F W Wood Jr, Vitro Labs*
These designs vary from custom-made to useful makeshift handles 90

BEVEL-GEAR CALCULATIONS . . . *B J Mumken, Sier-Bath Gear & Pump Co*
The answers came faster with this step-by-step method 93

FIELDS OF INTEREST REPRESENTED IN DEPARTMENTS:

MATERIALS:
Thermal conductivity of organic compounds gives test method. 36
Graphite powders show way to better lubricants 35

MECHANICAL:
Shock and vibration isolator for temperatures to 500 F. 97
Combination instrument measures output of very small motors. 36

ELECTRICAL:
High-temp potentiometer checks actuators and components. 98
Solenoid responds linearly to signal current. 35
The latest on high-temperature fuel cells 36

PRODUCT DESIGN:
Hub drives its own wheel in this power package 75
Seagoing vehicle uses industrial components 76
Two armatures drive sealed, instrument motor 77

PNEUMATIC-HYDRAULIC:
Connector handles air or liquid pressures to 4000 psi 97
Pressure-controlled valve does many jobs in hydraulic circuit. 97

GENERAL:
Communist overtones in bitter fight to control Japan's R & D. 37
Invention in installments—the men who developed TV. 7
Earthmovers for tomorrow—our cover story. 5

How B&W JOB-MATCHED TUBING simplifies fabrication of hydraulic cylinders

... The complete range of sizes and types of finish plus close tolerances help to simplify fabricating operations.

... Quality control from start to finish in the tube making operations helps to speed up fabrication and to make a better product.

... Controlled heat treatment provides desired properties for ease of fabrication.

These are just a few of the reasons it pays to specify B&W Job-Matched Mechanical Tubing.

Call the tubing specialist at your local B&W District Sales Office, or write for Bulletin TB-352 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

Metal Show—Booth 528
International Amphitheater
Chicago—November 2-6

B&W

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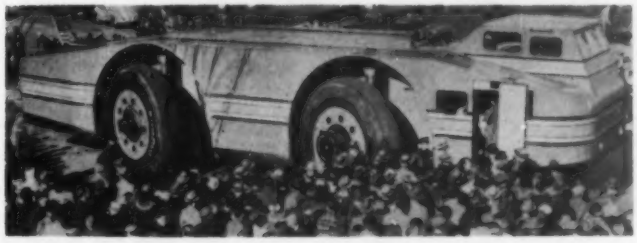
Interesting to Note . . .

Earthmovers for Tomorrow

Men, like ants, have always been earth movers. Five thousand years ago 100,000 slaves spent 30 years building the Great Pyramid of Cheops. They displaced a volume of earth greater than all but the largest of modern dams. It took 18 years and thousands of men to construct the earth-filled Great Wall of China. The 1400-mile wall required 72 million cubic yards of earth, almost three times as much as handled on the original Pennsylvania Turnpike.

When Holt and Best developed the crawler tractor in 1904, (Aug 18 '58, p 7) the construction industry got a tool it had been needing for centuries. Earthmoving machinery developed quickly. One of the latest developments is the motorized wheel built by GE and described on page 75. It includes a traction motor as an integral, carrying part of the wheel.

Our cover is an artist's conception of tomorrow's earthmoving machinery—all equipped with motorized wheels. In 1939, General



Electric Co's Locomotive and Car Equipment Dept used wheels driven by an electric drive directly on the "snowcruiser" shown here, built for the late Admiral Byrd when he went to the Antartic. When the current IGY expedition returned to the South Pole this year, they found the "Snowcruiser" intact under tons of snow, still in working order.

A Matter of Color

During the Korean War, UN forces dropped leaflets to the Chinese promising $100,000 reward for the pilot who would fly a MIG jet intact to the UN troops. The leaflet was printed

CONTINUED ON PAGE 7

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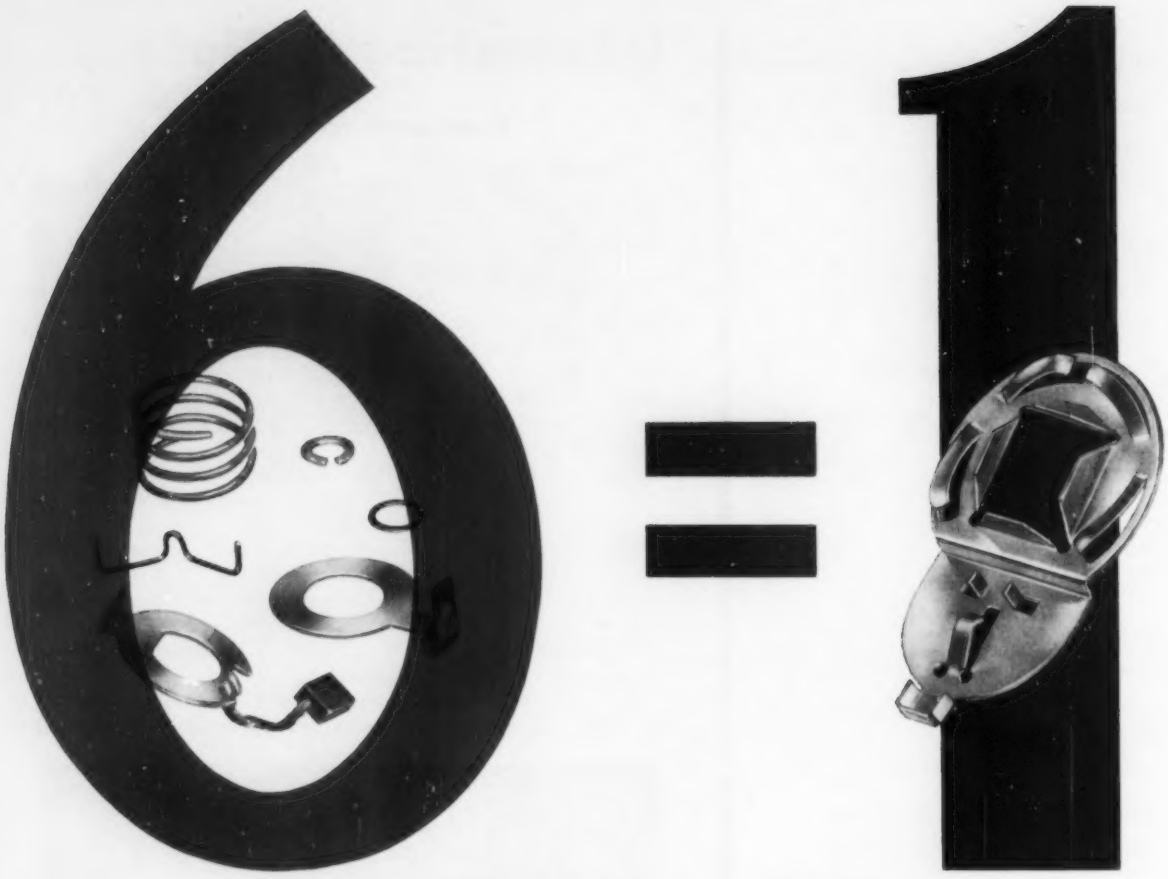

with re-design 'rithmetic

One flat spring now does the work previously required of the six parts shown—and greatly simplifies assembly, too. This single multi-purpose spring (a) holds a carbon brush in a rheostat, (b) applies pressure on the wire windings, (c) provides friction detent action, (d) acts as a retainer on the rotating shaft.

How did this come about? The maker of the rheostat undertook a complete redesign analysis, called in an A.S.C. Spring Engineer when it concerned the spring.

Early consultation with A.S.C. springmakers in new or redesign projects gives greater range to plans, safeguards against high production costs. Our booklet, "Designing Springs for Performance," may help you. Write for your copy.

5902

Associated Spring Corporation

General Offices: Bristol, Connecticut

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B-G-R Division, Plymouth and Ann Arbor, Mich.
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in black on a blue background. To the Chinese, a black-blue color combination symbolizes the lower classes. The leaflet had little effect upon the Chinese troops. Had it been printed in red-on-white, traditional in China for important notices, the results might have been different.

Every year more and more color psychology is being used in business and industry. When a margarine company recently found its sales dropping off, it called in color psychologists to see if there was anything wrong with the design of the new package. They found the reason. The package showed a piece of margarine enclosed in a cake of blue ice. Ice combined with blueness started off a chain of associations in the minds of consumers—blue and cold, lifeless, synthetic. When the company changed their package design to show margarine as part of a yellow and green flower (warmth, health, life, fertility, nature) their sales picked up rapidly.

An oil company in India did a tremendous business when they decided to sell their product in a can on which a red monkey was painted. The monkey god Hanuman is very popular in Indian mythology, and red is the color of Brahma, the Hindu's greatest god. A radio manufacturer found out he could make nothing but blue sets for certain native tribes in Northern Rhodesia. Blue was the only color that did not clash with the hundreds of tribal superstitions. Another firm found no market for its pins in China. Nobody would buy them because they were in a dark blue package, the color of death to the Chinese.

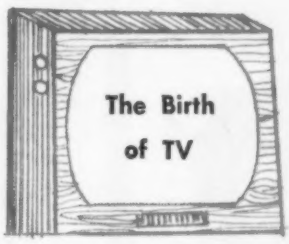
The *New York World Telegram and Sun* recently told about Natale Costa, a newstand operator in New York. He painted his drab olive green stand a bright canary yellow and watched his sales jump 100%. "Yellow's the best for a customer," said Costa. "It wakes 'em up, just like the sun in the morning. Some's in a hurry to get home. When they get here they got to open their eyes. And then they remember to buy a paper."

Now that Newton's classical color theory is being challenged by today's physiologists, color has taken on more importance to engineers. The article on page 67 tells how color coding can be applied to your products.

Priestley Cola

Air, necessity of all living creatures, is being restudied in light of our space age requirements. Engineers are taking a second look at its properties (p 71) in order to determine what design changes are in the offing. The importance of oxygen has never been questioned. Even before Priestley discovered what he called dephlogisticated air (oxygen), early scientists and alchemists before them knew air (as we call it today) to be one of man's vital elements.

Aside from being credited with the discovery of oxygen, (actually Karl Scheele in Sweden discovered oxygen about the same time, but Priestley published first) Priestley invented our common soda water. When he was a young minister in England, his home was adjacent to a brewery. One of the brewery's byproducts was an odorless gas called "fixed air" later known as carbon dioxide. Priestley found that by passing this "fixed air" through water a "potable beverage" resulted. This charged water was given to the British Admiralty as a possible cure for scurvy but it wasn't effective. Nothing was done about Priestley's fizz water for many years. Then when the soft drink industry started to boom, the inventor of soda water was totally forgotten.



So many of our household appliances can trace their origins back to a rickety hand operated machine conceived and first built by an inventive individual—the sewing machine, phonograph, telephone, washing machine, vacuum cleaner, etc. In today's era of invention by committee, there are few individuals who can lay claim to a major invention. The television set is a good example of an invention where several scientists can take credit for developing separate portions of the complete unit.

When Heinrich Hertz's photo-electric cell was improved by Elster and Geitel in 1905, the first step towards a living room TV set had been taken. Several years later, a further advance was made by the English scientist, Campbell-Swinton, when he proposed the use of the newly developed cathode-ray tube for the transmission and reception of images. In America, Vladimir Zworykin also realized that the cathode-ray tube would provide the answer and in 1919 set about trying to sell the idea to his employers, Westinghouse. They weren't interested in picture transmission, but allowed Zworykin to work in their radio lab. This didn't give the young scientist time to advance his theories on picture transmission so he left Westinghouse and joined RCA.

An image dissecter tube was developed by Philo Farnsworth, an American working in his small West coast laboratory. This important ingredient was necessary to make up the whole of the television concept. By 1939 several companies in this country and abroad were ready to put all these advances together and give TV a commercial try. The following year the US government authorized limited commercialization of TV, but a World War provided complications. Wyatt Earp had to wait for the Japanese to finish shooting before he could oil his famous .45.

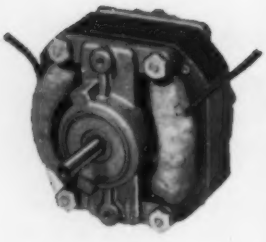
—Benedict A Leerburger Jr.

New! Complete, Expanded Line of Shaded

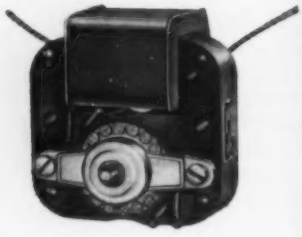
HOWARD

Newly expanded with the recent additions of the former Fairchild and Scruggs models, the all-inclusive Howard line of shaded pole and induction motors is now the most comprehensive in the industry. The wide selection of standard shaded pole and induction models offered by Howard assures you of a motor to meet your *exact* requirements at low cost and with minimum delay. Thousands of specs are on file so that variations of any standard model can also be quickly and inexpensively supplied. Shown on these pages are just a few of the shaded pole and induction motors in the Howard line. For samples and prices or information on these or other Howard motors—Universal, Gear motors or Blowers (not shown)—send us details of your application today.

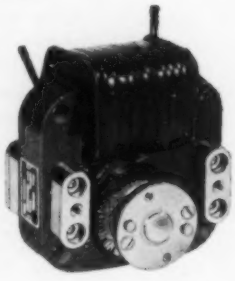
Shaded Pole Motors 1/2000 to 1/8 H.P.



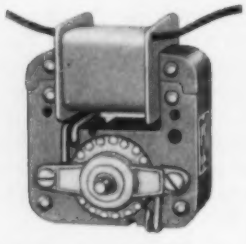
MODEL 100
TYPE: 4 pole, double bearing
DIAMETER: 2-3/4 square
LENGTH: 2-5/32 to 2-29/32 depending on stacking
H.P.: 1/650 to 1/85
NO LOAD RPM: 1700
FULL LOAD RPM: 1500 standard
BEARINGS: Sintered bronze, self-aligning type or ball bearings. Extension oil tubes available.



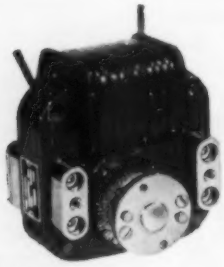
MODEL 1000
TYPE: 2 pole, double bearing
WIDTH: 2-3/8
HEIGHT: 2-19/32
LENGTH: 1-5/8
H.P.: 1-1000 to 1/75
NO LOAD RPM: 3400 - 3500
FULL LOAD RPM: 2800 - 3200
BEARINGS: Oilite with large oil reservoir.



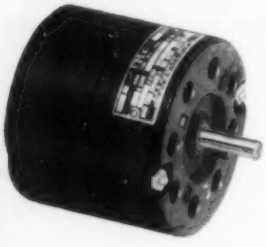
MODEL 1075
TYPE: 2 pole, unit bearing
WIDTH: 2-3/8
HEIGHT: 2-5/8
LENGTH: 1-3/4
H.P.: 1/750 to 1/185
NO LOAD RPM: 3400
FULL LOAD RPM: 2600 - 3200
BEARINGS: Unit bearing construction with permanently sealed-in lubrication.



MODEL 1100
TYPE: 2 pole, double bearing
WIDTH: 2-1/2
HEIGHT: 2-15/16
LENGTH: 1-1/2 to 2 depending on stacking
H.P.: 1/750 to 1/50
NO LOAD RPM: 3400
FULL LOAD RPM: 2800 - 3200
BEARINGS: Oilite with large oil reservoir.



MODEL 1175
TYPE: 2 pole, unit bearing
WIDTH: 2-1/2
HEIGHT: 2-31/32
LENGTH: 1-49/64 to 2-5/8 depending on stacking
H.P.: 1/700 to 1/100
NO LOAD RPM: 3400
FULL LOAD RPM: 2600 - 3200
BEARINGS: Unit bearing construction with permanently sealed-in lubrication.

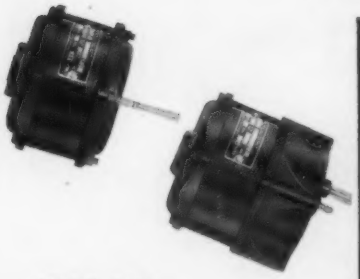


MODEL 2800S Stamped Steel Case
TYPE: 2 pole or 4 pole shaded pole
DIAMETER: 3-9/32
LENGTH: 2-3/16 to 3-1/16 depending on stacking
H.P.: 1/100 to 1/30*
NO LOAD RPM: 1700 or 3400
FULL LOAD RPM: 1500 or 3000
STARTING TORQUE OZ. IN.: 2.0 - 10.0 depending on stacking
BEARINGS: Porous bronze sleeve type with large oil reservoir.
*Ratings are continuous duty, 55° C rise in a 40° ambient, with air drawn over the open ventilated motor.

Pole and Induction Fractional H. P. Motors

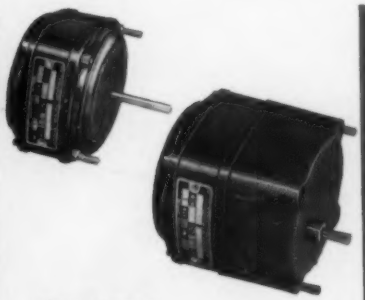
Now Offering the Widest Selection of Motors and Prices in the Industry!

Induction Motors 1/1400 to 1/4 H.P.



MODEL 2400

TYPE: 4 Pole Induction.
DIAMETER: 2-9/16" square.
LENGTH: 2-3/8" to 3".
SINGLE PHASE CAPACITOR MOTOR.
Maximum Torque oz in.—1.
Full Load Speed R.P.M.—1150.
Bearings—RBC—Ball. RWC—Sleeve.
TWO PHASE MOTOR:
Maximum Torque oz. in.—1.5.
R.P.M.—1150.
Bearings—RBC—Ball. RWC—Sleeve.
BEARINGS: Porous bronze sleeve type with oil reservoir, or grease sealed ball bearings.

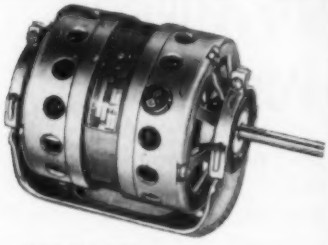


MODEL 2500

TYPE: 2 pole or 4 pole induction.
DIAMETER: 2-9/16" square.
LENGTH: 1-7/8" to 2-3/8".
SPEED: *1200 to 3600 R.P.M.
H.P.: 1/300 to 1/1400.
MAXIMUM TORQUE OZ. IN.: *1.6 to 3.5.
BEARINGS: *Ball or sleeve.
*Dependent on type of motor used, i.e. Non-Synchronous Capacitor Motors, Torque Motors, Standard Synchronous Motors, Hysteresis Synchronous Motors.

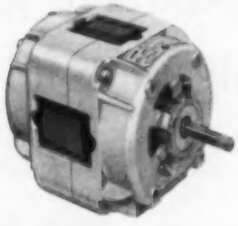
MODEL 2900

TYPE: 2 Pole, 4 Pole, 6 Pole or 8 Pole Induction.
DIAMETER: 3-5/16".
LENGTH: 4-25/32" to 5-21/32" ball bearing.
5-5/16" to 6-3/16" sleeve bearing.
H.P.: *1/70 to 1/15.
FULL LOAD TORQUE OZ. IN.: *10.0 to 30.
BEARINGS: Bronze sleeve type with oil reservoirs, or permanently lubricated sealed and shielded ball bearings.
*Dependent on type of motor used: i.e. Non-Synchronous Capacitor Motors, Standard synchronous, Motors, Hysteresis Synchronous Motors. Torque Motors.



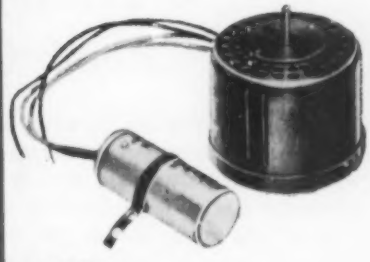
MODEL 3700

TYPE: 2 Pole, 4 Pole, 6 Pole or 8 Pole Induction.
DIAMETER: 3-7/8".
LENGTH: 5-1/16" to 5-11/16".
H.P.: *1/25 to 1/7.
STARTING TORQUE: *13 oz. in. to 30 oz. in.
BEARINGS: Porous bronze type with oil reservoir.
*Dependent on type of motor used; i.e. Normal Induction Motor, Hysteresis Synchronous Motor.



MODEL 9200

TYPE: Induction, torque, synchronous 2, 4, 6 or 8 poles, 25 to 60 cy single (capacitor) two or 3 phase.
H.P.: 1/250 to 1/50 continuous or intermittent duty.
R.P.M.: 900 to 3600.
DIMENSIONS: 2-7/8" x 2-7/8" by 4-1/32" to 4-13/32".
MOUNTING: Pad, resilient ring, face extended bolts.
BEARINGS: Porous bronze sleeve, (ball bearings available at request).



MODEL 1

TYPE: Hysteresis Type Single Phase Capacitor
DIAMETER: 2-5/8
LENGTH: 2-3/16
H.P.: 1/500 to 1/200
SPEED: 3600 RPM
FULL LOAD TORQUE OZ. IN.: .6 to 1.35
BEARINGS: Sleeve or ball.

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Your valuable original drawings resist absorption of moisture, slow deterioration, tearing and rough handling when you use drafting film made of Du Pont "Mylar"* polyester film. That's because the base—durable "Mylar"—is tough, flexible and stable. And "Mylar" won't dry out or become embrittled with age.

Drafting film of "Mylar" provides good contrast for microfilming . . . makes paper intermediates unnecessary. Because it costs less than many grades of tracing cloth, drafting film of "Mylar" provides you with many new cost-saving opportunities.

So next time you order, ask for pencil and ink drafting films of "Mylar". . . *safeguard your investment* in drafting time and labor.

If you would like samples for testing, we will ask manufacturers of drafting film of "Mylar" to send you a sample. Write E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room PE-9, Wilmington 98, Delaware.

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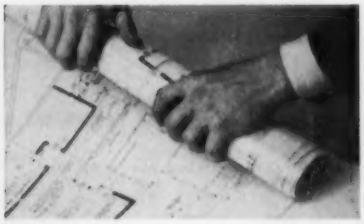

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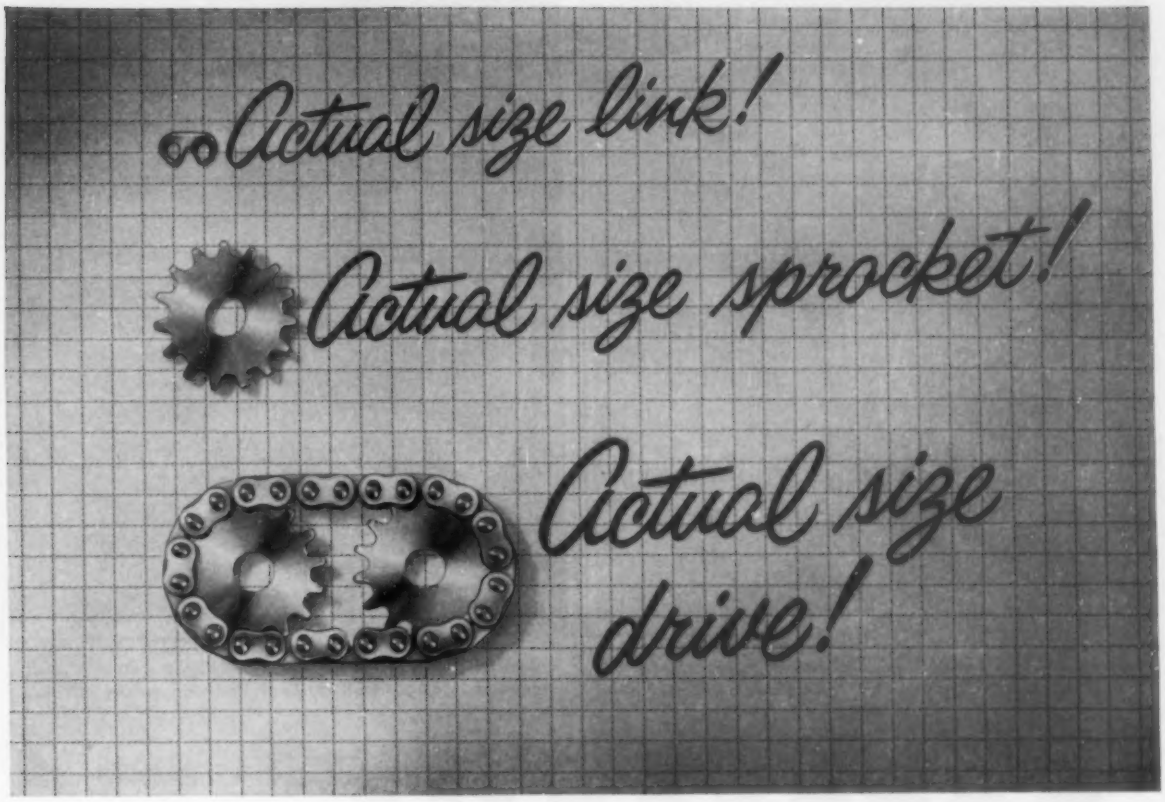


. . . and actually over 98% efficient

LINK-BELT 3/16" PITCH SILENT CHAIN

Complete drives as small as two inches! Weight as little as .07 pounds per foot! Efficiency better than 98%! Link-Belt 3/16-in. pitch silent chain is the perfect combination of compactness and split-second precision.

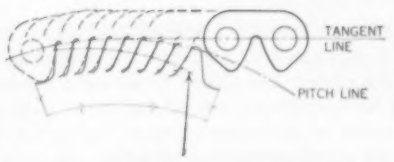
At high or low speeds, this chain is quiet, positive, smooth. In fact, with its unique link design, it's the smoothest-running chain in use today. In many limited-space applications, it has replaced expensive, precision-cut gear trains. And its versatility makes it ideal for a wide assortment of equipment—ranging in diversity from cigar-making machines to guided missile controls.

Available in carbon and stainless steels . . . for ratios up to 12:1, speeds over 7500 rpm. For full details, contact your nearest Link-Belt office. Ask for Book 2510.

LINK-BELT

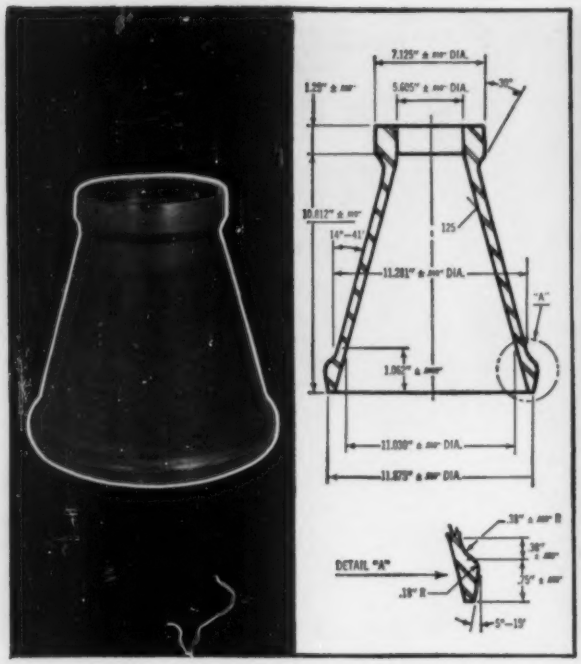
SILVERSTREAK SILENT CHAIN DRIVES

NO CHORDAL DISTURBANCE!

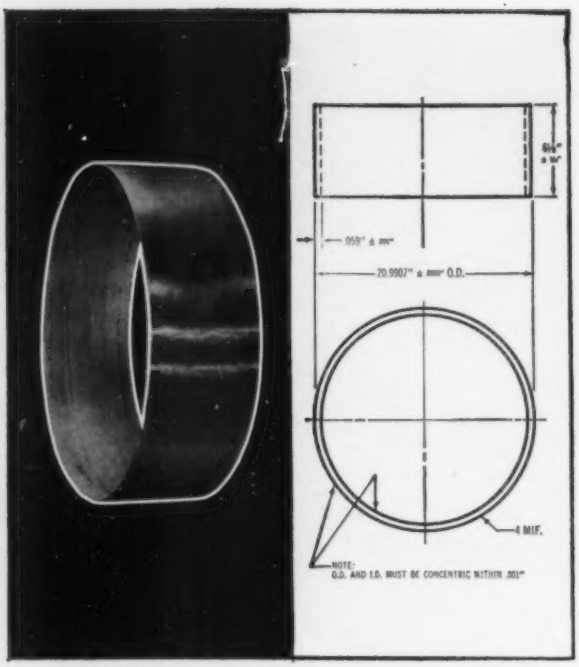


Exclusive link form of Link-Belt 3/16-in. pitch silent chain permits chain to enter the sprocket wheel on a line tangent to its pitch circle, thus eliminating the undesirable effects of chordal disturbance.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,160



STRAIGHT SIDE ROCKET CONE—Spun with tapered wall from 1020 steel blank: 18" diameter, 1" thick. Inside surface 125 MIF.



STRAIGHT WALL TUBE PRINTING BAND—Spun from ⅛" thick aluminum to .060" wall thickness, outside surface machine finished to 4MIF.

ROTOFORMS open new

ROTOFORMING reduces cost of unusual metal shapes—saves metal, eliminates machining and surface finishing

The design possibilities for hollow metal shapes are now unlimited. The most unusual metal custom parts can be practically and economically produced by ROTOFORMING.

This revolutionary new metal forming service now being offered by COMMERCIAL SHEARING & STAMPING displaces metal in a blank or preform. Rollers contacting the outside surface of the metal form it by high pressure as it rotates around a mandrel. The shape of the mandrel itself, at all times, controls the inside contour and size of the part.

WHAT SHAPES ARE POSSIBLE? Basically, ROTOFORMS can be grouped into four main categories: Straight-Side Cones, Straight-Wall Tubes, Curvilinear-Wall Shapes, and Elliptical or Hemispherical Shapes. Pictured above are representative ROTOFORMS already produced by COMMERCIAL. Principal dimensions are included.

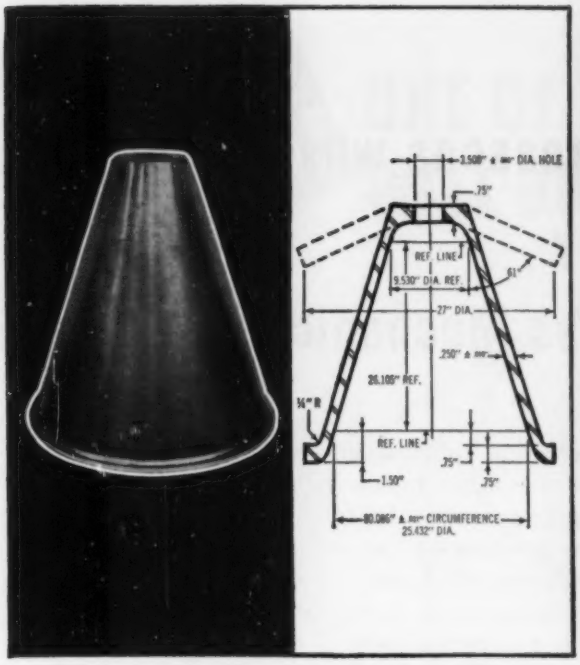
WHAT ABOUT SIZE AND WALL THICKNESS? The range of sizes for ROTOFORMS covers maximum diameters up to 42" down to a minimum tube I.D. of 2¼". Tube length can go as high as 100".

Steel blanks up to ¾" thick can be successfully handled by ROTOFORMING where conical shapes are involved. And when it comes to forming straight-wall tubes the wall thickness of steel blanks can even go up to ⅝". When forming metals more ductile than steel it is possible to work blanks with even greater wall thicknesses than those above.

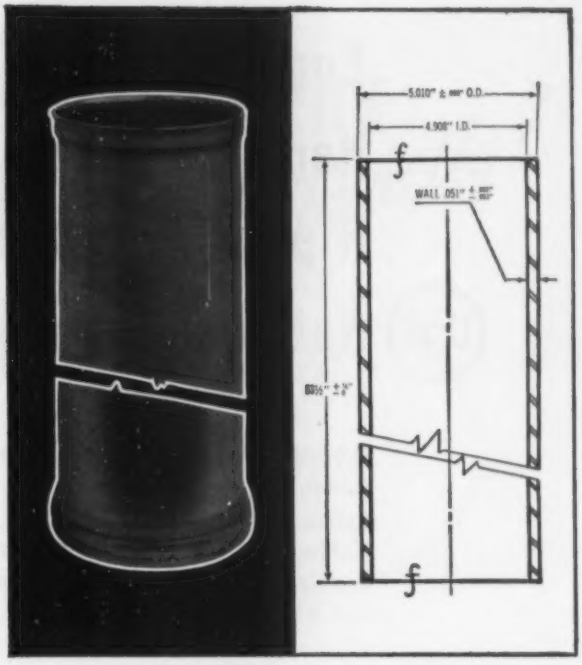
With ROTOFORMS wall thicknesses—both constant and variable—are feasible. Walls referenced to C/L can be straight, curved, or tapered. And ROTOFORMS have been successfully produced with a finished wall thickness no greater than 1/32".

WHAT METALS CAN BE ROTOFORMED? A wide variety of carbon steels, stainless and special alloy steels, as well as aluminum, nickel, copper, molybdenum, magnesium and titanium alloys can be successfully ROTOFORMED. Even metal alloys such as 4130 steel, 1100-0 aluminum, and hard to machine Hastelloy, can and are being used in the regular production of ROTOFORMS.

WHAT HAPPENS TO THE METAL? The plastic deformation which metals undergo in the ROTOFORMING process elongates their grain structure and sub-



STRAIGHT SIDE MISSILE EXIT CONE—Spun with constant wall thickness from press pre-formed 1040 steel blank: 29" diameter, ¾" thick.



STRAIGHT WALL ROCKET TUBE—Spun from 4135 steel tubing (wall thickness ½") reduced to finished wall .051".

horizons for metal shape design!

stantially increases their strength. Tensile increases 1½ to 2 times, yield point is raised in even higher proportion, and fatigue strength is substantially improved. And ROTOFORMED parts can be heat treated to increase their ductility.

Because of the plastic deformation of metal, involved weld joints become unnoticeable when ROTOFORMED. And there are no hidden metal flaws in ROTOFORMS. Any metal inclusions or flaws in the parent metal are quickly uncovered during the ROTOFORMING process—appear as ruptures when pressure spinning rolls reposition the metal by physical displacement. Only 100% sound metal will produce successful ROTOFORMS.

WHAT ABOUT TOLERANCES AND FINISHES? Extremely close tolerances and tolerances commonly associated with fine machining are routine in the production of ROTOFORMS. It is not uncommon for ROTOFORMED parts taken from the machine as is to have inside diameters held to tolerances of +.000" −.003", +.005" −.000", and +.005" −.005".

Inside areas of ROTOFORMS finish to a glass-like surface—30 to 60 micro inch finishes being well within standard production practice. While outside surfaces finish to about 125 micro inch.

Because dimensional tolerances and inside surface finish have a direct relation to the variation and finish of blank from which the ROTOFORM is produced, when necessary the tolerances of a blank can be reduced and its finish improved beforehand in order to provide closer tolerances and a better inside finish in the actual ROTOFORM. In addition, the outside surfaces of ROTOFORMS can be brought to smoother finish by grinding, polishing or fine machining.

AN INVITATION FROM COMMERCIAL! This new metal forming process could be the practical and economical answer to your particular component problem. You can find out very quickly. Just a blueprint, sketch or prototype of your part in the hands of our engineers will bring you the complete cost-saving story—and at no obligation. Address inquiries to Commercial Shearing & Stamping Co., Dept. G-38, Youngstown 1, Ohio.

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Engineers:
Here are sound reasons why it pays to specify
USS National Seamless Mechanical Tubing

USS National Seamless Steel Mechanical Tubing offers you extraordinary freedom of design in a wide range of products from bushings to hydraulically operated telescoping booms. And, USS National Seamless Tubing helps cut processing costs, because it eliminates drilling operations; enables you to replace drills with simple, less expensive boring tools, and it reduces tool wear and tool changes; and, more important, more uniform parts can be turned out by the hundreds or thousands.

Where USS National Seamless Tubing is used as a load-carrying member or part, it exhibits a number of structural advantages over other forms. *Here are a few:* it gives you a superior cross section when a part is designed to withstand equal loading in any direction; it resists bending stresses equally in all directions; it is able to absorb and localize shock; and in torsion, it provides better material distribution, and for a given weight, can withstand more load than other sections.

And, of course, the name USS National is backed by the world's largest and most experienced manufacturer of seamless tubing—National Tube! The production of USS National Seamless Tubing, from ore to finished product, is entirely controlled by one organization. There is no divided responsibility. Every foot, every length, is made under the careful supervision of skilled men with years of tubemaking experience. For more than 60 years, USS National Seamless Tubing has been first with men who want the best in mechanical tubing.

You'll find USS National Seamless Tubing available at select National Tube Distributors throughout the country. These distributors are strategically located and expertly trained in solving all types of tubing problems. Here, you can choose from a complete range of sizes and stocks. If you'd like to find out how USS National Seamless Tubing can be most effectively applied to your designs, contact your nearest USS National Distributor . . . *soon!*

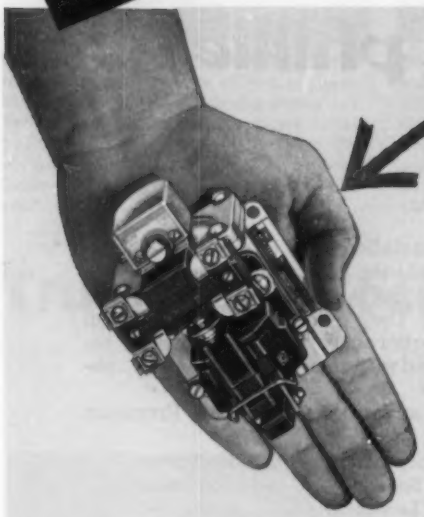
USS and National are registered trademarks

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

What's Your Timing Problem?

–ONE OF THESE TIMERS WILL DO YOUR JOB *Exactly!*



NEW...Type A

REALLY SMALL IN SIZE AND COST!

for applications requiring shorter timing periods, ±15% accuracy and no interlocks

Type B

MACHINE TOOL STANDARD FOR MORE THAN 20 YEARS!

for applications requiring timing periods up to 3 minutes, maximum accuracy and 1 or 2 instantaneous interlocks

COMPARISON	TYPE A	TYPE B
Timing Period	.2 to 1 min.	.2 to 3 min.
Accuracy	±15%	±10%
Interlocks	None	Max. 2 Double Circuit
Panel Space	2⅜" x 4"	2½" x 7⅜"
Convertible Delay-On • Delay-Off	Yes	Yes
Maximum Voltage AC—DC	600 V. AC only	600 V. AC 250 V. DC

Write for Timer Bulletin 9050
Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

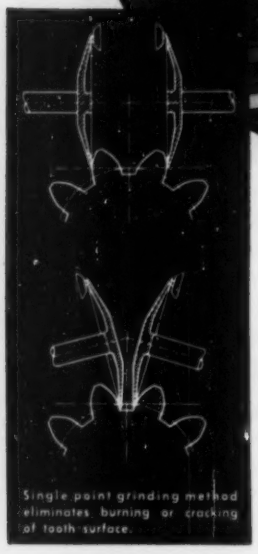
NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE

SQUARE D COMPANY

a new concept in

GEAR TOOTH ACCURACY

by phillie gear



Single point grinding method eliminates burning or cracking of tooth surface.

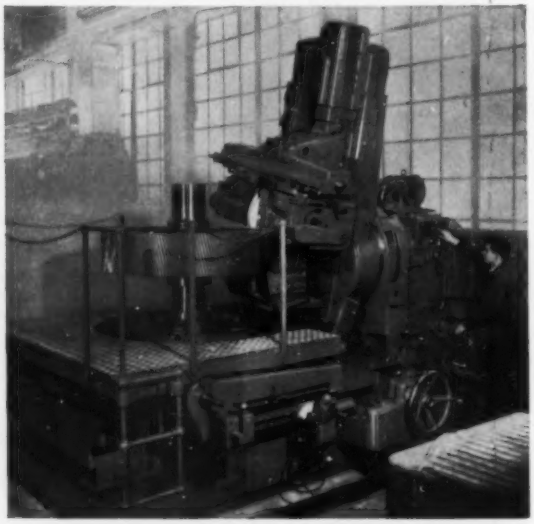
We have recently installed five of the latest Precision Grinding Machines to produce gears of absolute accuracy and surface finish . . . Gears so truly accurate that they will solve transmission problems never conquered before, because you secure technical and engineering advantages not previously obtainable.

Briefly, here are some of the advantages of Ultra Precision Gears ground on these machines:

Greatly Improved Profile Accuracy . . . 100% Interchangeability . . . Higher Operating Speeds . . . Increased Load Carrying Capacity . . . Longer Service Life . . . Space and Weight Savings . . . Reduced Noise and Reduced Vibration . . . Reduced Backlash . . . Greatly reduced tooth to tooth errors . . . This adds up to an improvement in your product.

Of course, we have only "touched the surface" in this advertisement, but if you get in touch with us, we will give you complete information about this Ultra Precision Gearing . . . No obligation.

Illustrated is one of our latest gear grinders for Spur and Helical Gears up to 72" diameter . . . ultra precision work table is accurate within 4.3 arc seconds total accumulative error. THIS MACHINE IS THE MOST ACCURATE LARGE GEAR GRINDER IN AMERICA.



Send for our latest 76 page "Gear Book" . . . it's practically a treatise on the subject of gears . . . Please use your business letterhead when requesting a copy.

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

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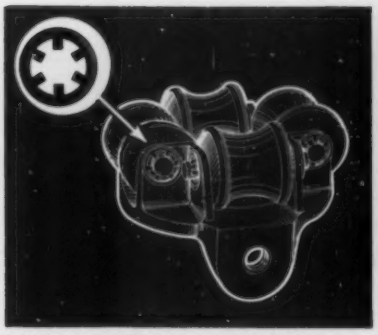
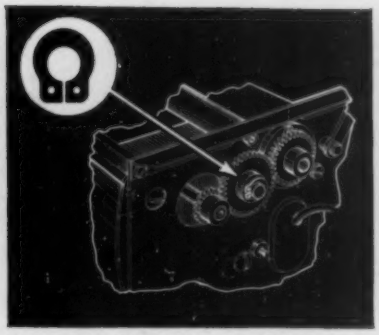


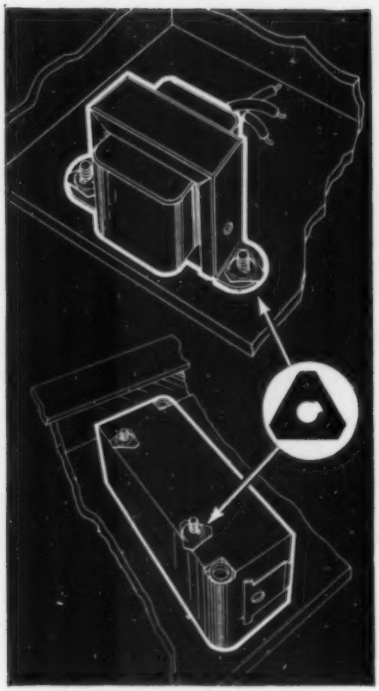
Drilling and flaring eliminated. Easier maintenance, a time saving of 50% and elimination of costly, time consuming drilling and flaring operations result when Truarc Series 5115 self-locking rings are used to retain rollers on pins in this electric cable guide. Extra long prongs enable ring to accommodate wide shaft tolerances.



Economical fastening for idler gear. Installing Truarc Series 5555 Grip Ring flush with hub insures precise seating of gear in this portable electrocardiograph assembly. What's more, the ring eliminates a nut and costly stud-threading operation of alternate design. **Typical savings amount to $365 per 1000 units.**

Cross-drilling and cotter pin eliminated. Here a Truarc Series 5305 self-locking triangular retainer replaces a cotter pin used to hold an electric-motor mounting bar. Both the cotter pin and the cross-drilling operation required in the original design are eliminated. **Typical total savings amount to $120 per 1000 units.**

Truarc self-locking retaining rings boost economy in wide variety of designs



Easy way to mount electrical-electronic parts. Truarc Series 5300 triangular nuts replace conventional nuts and lockwashers in mounting electrical parts like transformer (top) or Microswitch (bottom). Dished body of Series 5300 flattens under torque, eliminates need for lockwasher, simplifies handling and assures assembly.

...eliminate parts, machining, speed assembly

Easy application, elimination of more expensive conventional fasteners and reduction or elimination of machining operations are just a few of the savings resulting from the proper use of self-locking retaining rings. Rings replace threaded retainers and nuts, hairpin-type cotter pins, and a variety of cut, lock, and plain washers. They require no groove, or preparatory machining operations. Rings can be installed by unskilled labor, seated at any point on the shaft, automatically taking up any accumulated tolerances.

Four ring types are shown. One has a dished triangular body which locks the fastener on the shaft under spring tension, holds under moderate shaft tolerances and against extremely heavy thrust loads. Another, a re-usable Grip Ring, is ideal for ungrooved shafts, tubes, bosses, and studs. A third type is a triangular free-spinning nut with a dished body that flattens under torque, eliminating need for separate lock washers. The fourth, a push-on type, has an arched rim to provide high strength and extra long locking prongs which accommodate wide shaft tolerances.

These are but four of the 50 functionally different types of Truarc retaining rings. They come in 740 standard sizes, 6 metal specifications, 13 different finishes. The entire Truarc line, including assembly tools, grooving tools, and 80 typical cost-saving applications, is covered in the new catalog RR 10-58. And remember, Waldes engineers are always ready to help you solve your application problems—whether they involve one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. 9.15

WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor, Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS . . . THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

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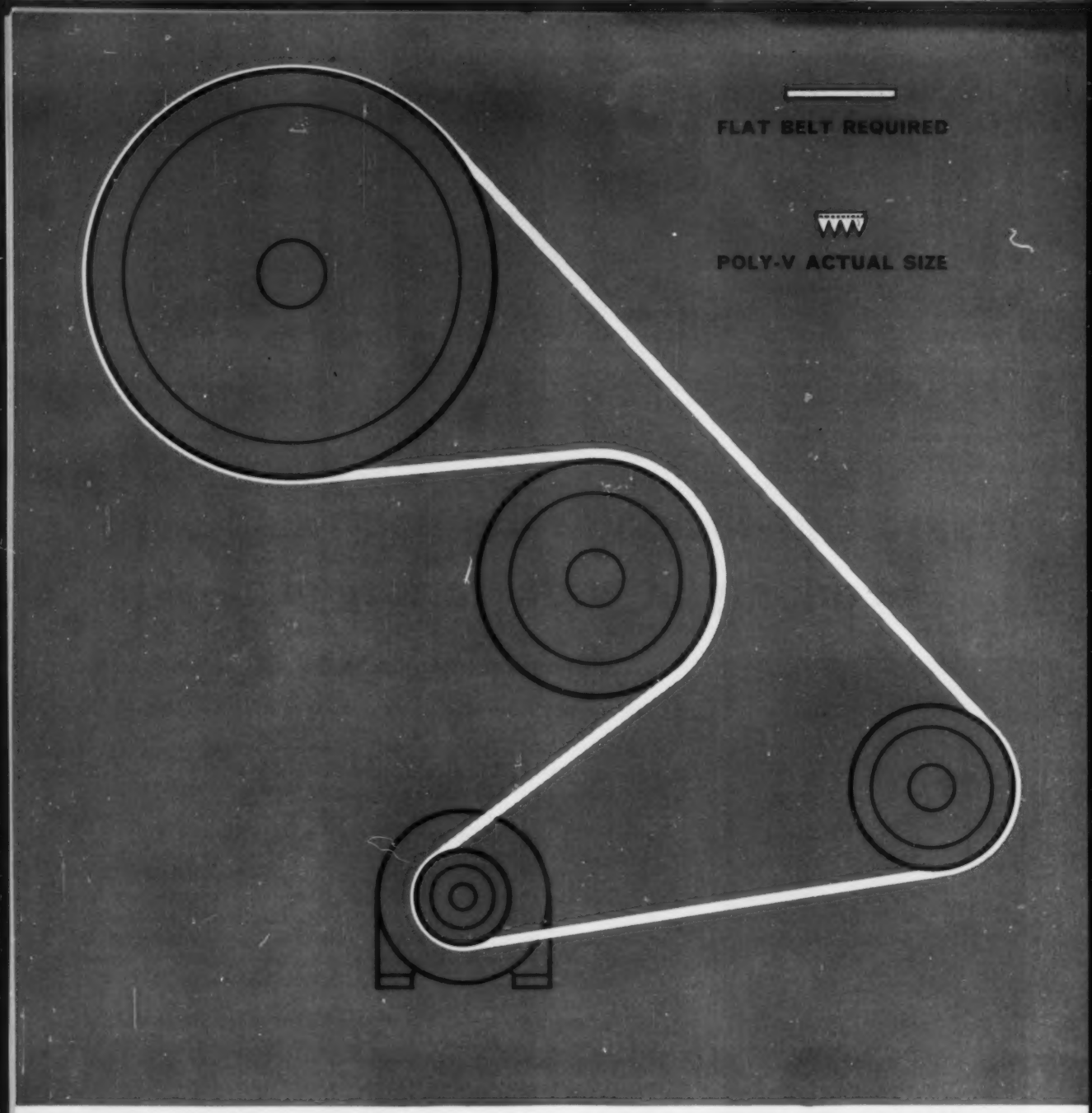
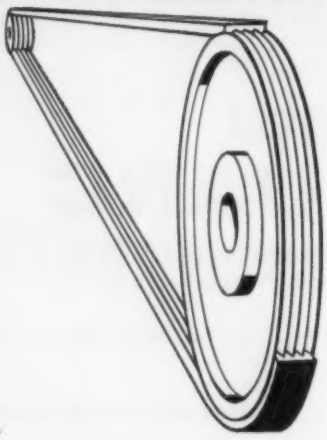




COMPACT, MODERN AUTOMATIC WASHER

Here's a typical example of efficient, compact, modern design—an automatic washer with a Dayton Poly-V Drive. Note that it imposes three design requirements, (1) a torturous back bend (2) sub-diameter pulleys (3) a limited tension take up area. Yet the design is efficient because Dayton V-belt engineers applied Poly-V to overcome these three punishing conditions.

As you can see, use of Dayton Poly-V results in important savings in space, weight and costs . . . a more compact and lighter drive because of greater flexibility and load carrying capacity. You'll also find that Dayton Poly-V drives protect you against expensive "warranty" service calls.

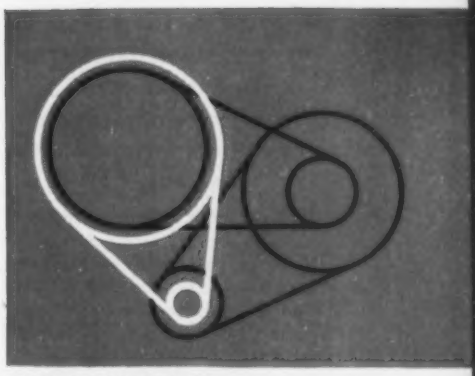
CIRCLE NO. 18 READER SERVICE CARD

Announcing a new Drive Engineering Service

New DAYTON POLY-V® Drives provide unique answer to problems of space-saving modern design...

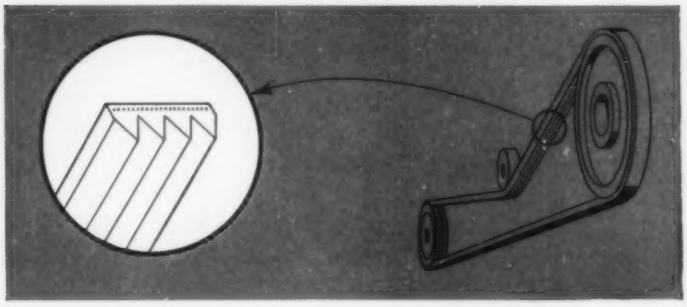
Delivers up to 50% more power in ⅔ the space. Never before has one product answered so many basic design problems . . . necessary to the rendering of tomorrow's more compact and functional appliances. Wherever greater power delivery is required within critical space limitations, Dayton Poly-V provides the answer with narrower sheaves, shorter centers, more speed ratios . . . *greater power delivery in less drive space.*

New Dayton Poly-V employs a single, endless parallel V-ribbed belt running in sheaves designed to mate precisely with the belt ribs. Single unit design provides twice the tractive surface per inch of sheave width . . . delivers up to 50% more power in as little as ⅔ the space where these requirements are indicated. This means *less* shaft overhang, less bearing load . . . a more compact and lighter drive. Single unit design completely eliminates need for matching belts, helps maintain constant pitch diameter and speed ratios from *no* load to *full* load. You get longer drive life . . . smooth vibration-free performance . . . greater dependability.



FULL POWER WITH SINGLE REDUCTION

Dayton Poly-V makes it possible to eliminate one stage of a double reduction drive. Its complete flexibility and high strength design takes high speeds (to 10,000 FPM) without snapping. Means it will deliver equal power in as little as ⅔ the space.



Back-side idler drives are no problem for the Poly-V longitudinal ribbed, highly flexible construction. Other belt drives crack from the force of flexing in a direction contrary to their normal construction. Dayton Poly-V offers long life, superior performance where others fail because of its uninterrupted synthetic cord construction running the entire width of the belt . . . providing amazing resistance to this gruelling drive condition.

®Registered trademark of R/M Inc. Manufactured by Dayton Rubber under exclusive license of Raybestos-Manhattan, Inc.

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Dayton Industrial Products Co.

Melrose Park, Ill.

A Division of The Dayton Rubber Co.

Make use of Dayton's special Drive Engineering Service when you think of power transmission ... when your design is still on the drawing board. Attach this coupon to your Company letterhead, fill in as indicated.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

DOW | **7 NEW IDEAS IN 7 MINUTES**

It takes two things to make the cash register ring today: New ideas—products that people really want—and new materials to make those ideas work. Many of these are plastics materials such as the large, widely diverse line of Dow thermoplastics. These chemically engineered materials give the product designer more latitude and the production man fewer headaches. Sales managers like them, too, because they contribute beauty, durability and *quality* in no small measure. Six members of the Dow family of plastics are portrayed on these two pages in seven different product improvement roles. Reading time: One new idea per minute.

STREAMLINED TV SETS:

NEW EPOXY RESIN BREAKS THE BULK BARRIER

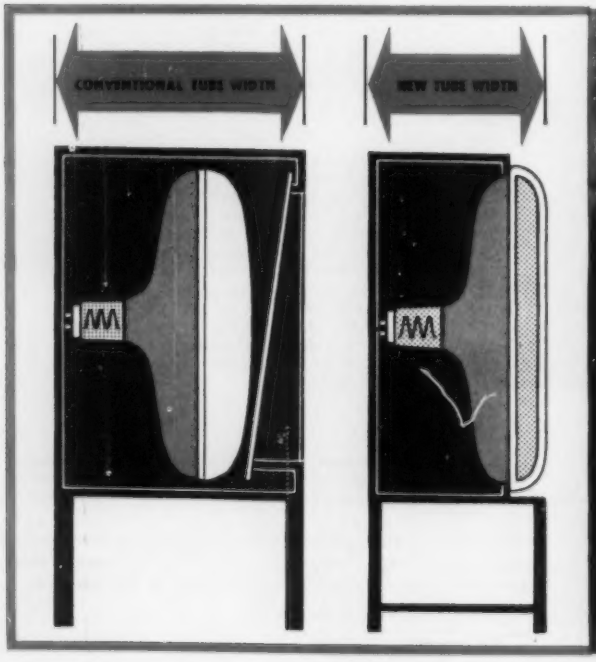
Brighter images, fewer reflections, larger picture areas also accrue from advance in TV tube design

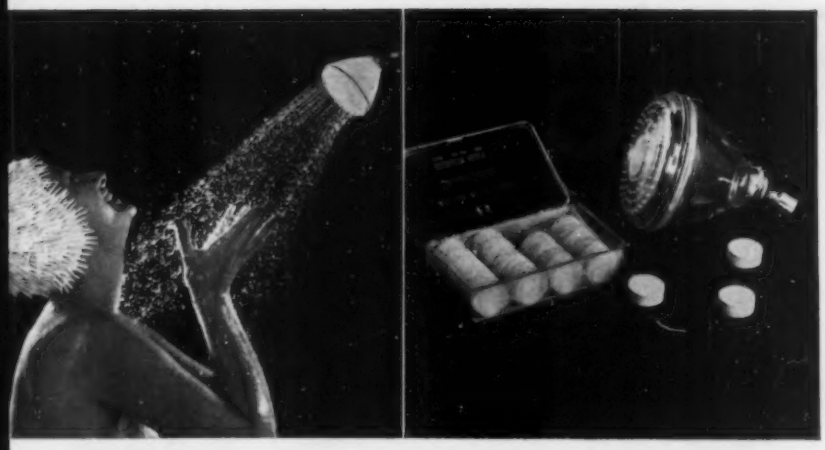
When the TV set manufacturers set out to streamline TV cabinets, the first and foremost problem they faced concerned the "picture tube". Conventional set design calls for a glass safety panel mounted in front of an oval-faced tube. If a contoured safety panel could be laminated directly to the tube, a saving of several inches in the depth of the cabinet would be possible and the tube face could be flatter and almost square due to the extra strength of lamination.

Tube manufacturers brought the problem to the attention of Dow's Coatings Research Staff. The requirements: A material that would firmly bond glass to glass, stand up under the heat generated by the tube and not interfere with the transmission of the picture in any way. And, of course, the material had to lend itself to lamination on a production line basis.

Dow resin chemists developed a new epoxy resin that met these requirements with properties to spare! After months of testing, this new material is now in widespread use.

Eliminating the separate panel has some other important advantages besides streamlining. The area between the tube and the panel always served as a dust catcher, resulting in fogging of the picture. Also, the separate panel often caused double reflections, or glare, in the viewer's eyes. The new integrated, square-faced tube means greater picture area without increasing the basic size of the set.





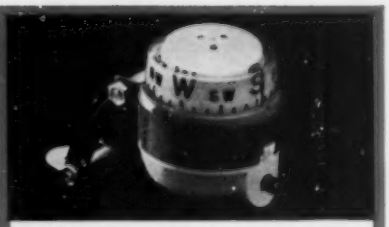
SALES POWER IN THE SHOWER

How would you like a shower fixture that softens, suds and scents the water? Just slip a soap pellet into this new type of shower head and you get a full three minutes of all three. A new product that has brought the sweet smell of sales success to its manufacturer, it's made of smooth, durable Styron® 683. Its crystal clarity harmonizes with any decor and lets you see if calcium deposits are building up inside. The excellent moldability of Styron 683 was put to good use in forming the minute spray holes.

HARDHEADED PERFORMANCE PAYS

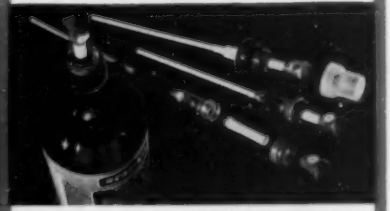
Sandlot grid stars wear this football helmet made of super tough Ethocel®. This lightweight, high gloss material is called the aristocrat of the thermoplastics because it has the best resistance to impact, especially at low temperatures. Thus this molded helmet offers a maximum of safety to young line chargers. Ethocel also resists weathering and is easy to clean. Like most Dow plastics, it is available in a wide range of colors. Its exceptional molding characteristics make large one-piece moldings practical and economical.

STYRON 480—Here's a trailer drainage system that will never corrode! Tough, durable Styron 480 can take the vibrations and bumps of normal trailer operation, has excellent chemical resistance.



TYRIL®—The housing of this car compass must be rugged, nonmagnetic and have good resistance to chemicals and distortion over a wide temperature range. These requirements make Tyril first choice.

PELASPAN®—New expand-in-place beads provide lightweight, durable insulation for this new cooler for sportsmen and picnickers. Pelaspan contributes maximum design flexibility, minimum production costs.



TYRIL—Tyril teams excellent dimensional stability and chemical resistance in this insecticide bottle top sprayer. Its superior moldability helps hold close tolerances on close-fitting parts.

• • •

THESE ARE JUST A FEW

of the countless ways Dow thermoplastics are helping to make new and improved product sales history. For more information about properties and applications of any Dow plastic, write to us today. THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. 1513DZ9-14.

Industrial Molding Materials

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Paint and Coating Materials

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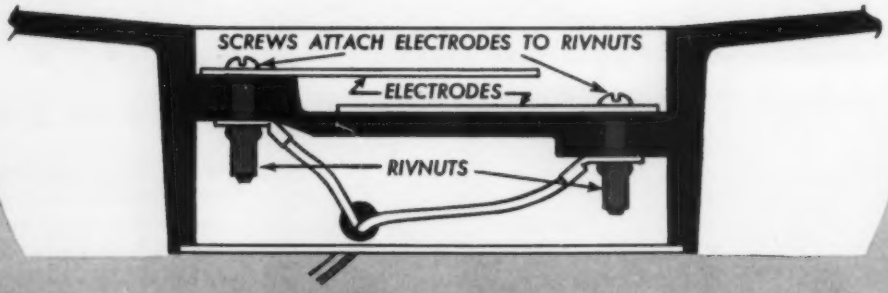
DOW

B.F.Goodrich

B. F. Goodrich RIVNUTS® simplify design, production of Hankscraft sterilizer



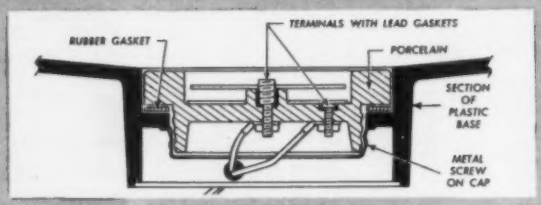
Here's why Hankscraft Company turned to B.F.Goodrich Rivnuts when they streamlined design, production and appearance of the Model 200A Baby Bottle Sterilizer.

Before Rivnuts, the electrodes and terminals were fastened to a large porcelain "dish" by screws and nuts. Four gaskets were required to prevent water leakage. A metal screw-on cap had to be fitted underneath the porcelain "dish". *(See small sketch)*

Rivnuts eliminate all these cumbersome pieces. Installed in the simplified plastic base, Rivnuts secure terminals, provide water-tight nut plates. Two screws attach electrodes — and the unit is complete.

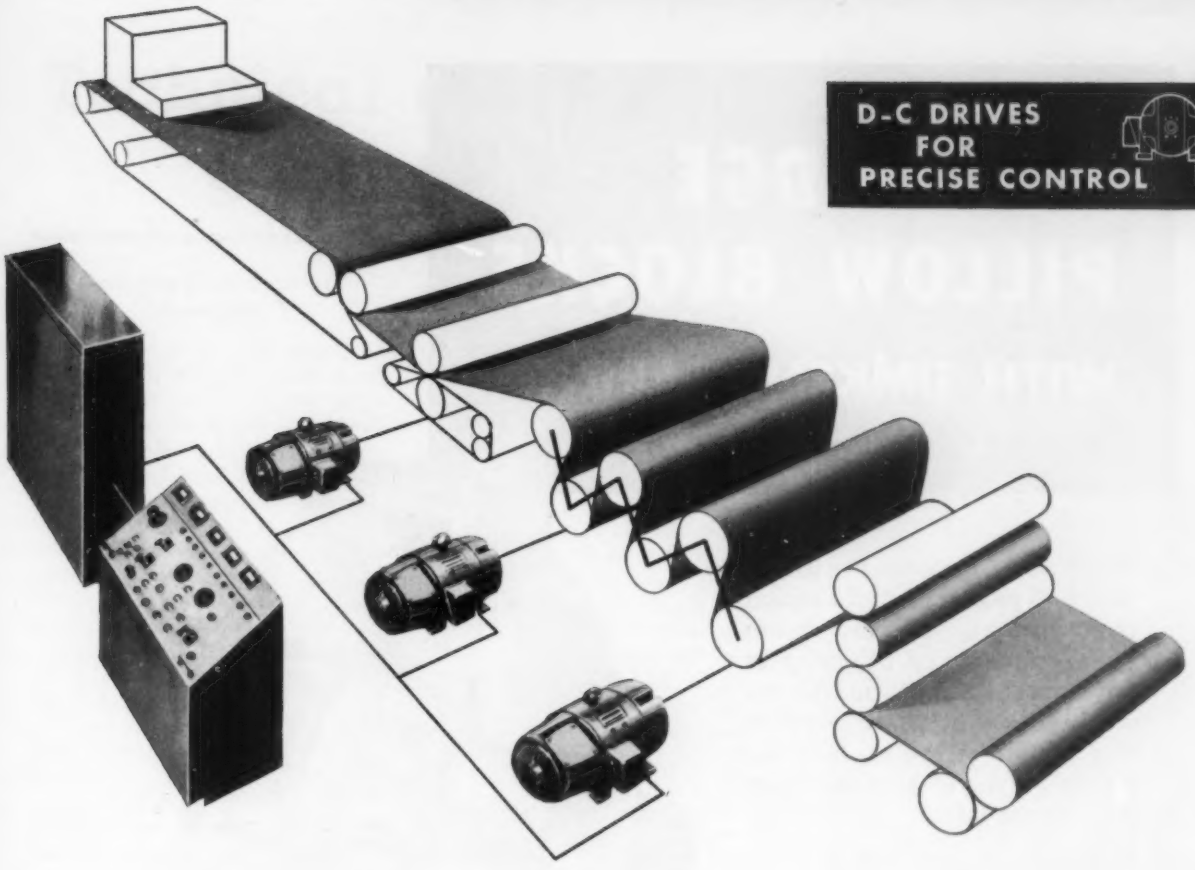
You can get B.F.Goodrich Rivnuts in thread sizes 4-40 to ½"-13 with flat or countersunk heads. Rivnuts have hundreds of applications in appliances, electronic equipment, machinery and structures. Special types are available for aircraft and missiles.

Write now for free copy of the Rivnut Data Book. Better yet, send us a sketch of your toughest fastening problem. *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.*



B.F.Goodrich ***aviation products***

D-C DRIVES
FOR
PRECISE CONTROL



Problem: How to coordinate two or more machines for greater production flexibility, lower costs

Operating at high speeds, working to close tolerances, meeting high-quality standards, today's machines must be controlled accurately. This is one of the reasons users and designers are making greater use of direct-current drives for coordinating two or more machines in multi-section process lines.

MACHINE COORDINATION IS A NATURAL JOB FOR DIRECT-CURRENT POWER. For direct current can best provide the accurate speed matching and extra measure of control needed for high-speed, automatic continuous processing.

D-c's flexibility allows each individual drive motor to be run at the exact speed demanded by the section of the process it drives. Increased output, better quality control and production flexibility lower the cost per unit of production.

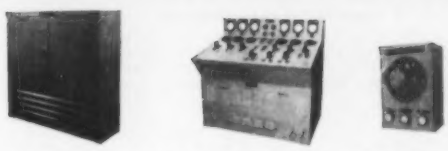
To learn more about the modern capabilities of direct-current power, write for your free copy of "WHY D-C?", *Section 829-3, General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

SELECT FROM GENERAL ELECTRIC'S COMPLETE LINE OF D-C DRIVES

MOTORS AND GENERATORS



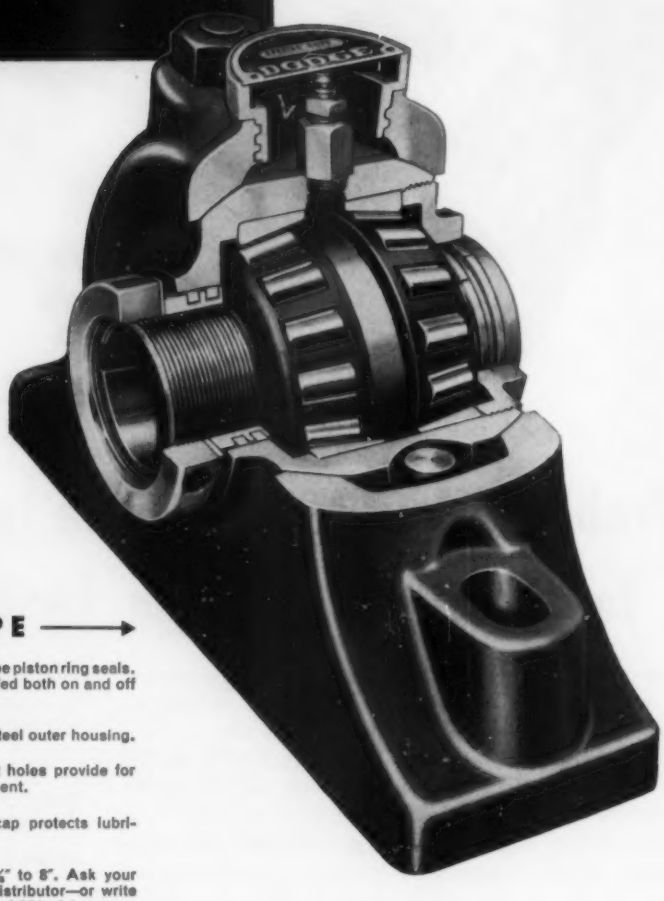
POWER UNITS AND CONTROLS

CIRCLE NO. 23 READER SERVICE CARD

DODGE PILLOW BLOCKS

WITH TIMKEN BEARINGS

America's super-quality line—with a 35 year record of keeping performance *up* and costs *down!* Five types—to fit practically any service condition. All assembled, adjusted, lubricated and *sealed* at the factory for precision performance—long life—dependability.



SPECIAL DUTY TYPE →

- Designed for extreme precision and high load capacities.
- Fully self-aligning.
- Special Duplex Timken Roller Bearing with tapered bore.
- Split tapered sleeve with straight cylindrical bore extends through entire length of housing.
- Easy to mount or demount. Adapter nut (or collar) clamps adapter sleeve to shaft with extreme firmness.
- Automotive type piston ring seals. Bearing is sealed both on and off the shaft.
- Rugged semisteel outer housing.
- Elongated bolt holes provide for lateral adjustment.
- Special dust cap protects lubrication fitting.
- Shaft sizes 1¾" to 8". Ask your local Dodge Distributor—or write us for Bulletin A670 giving complete technical data on America's most complete line of mounted bearings.

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.

Technical data for gasket design and selection

Sealing thin-section flanges

Very narrow flanges—as found, for example, on automotive oil filter housings—present unique sealing problems which should be considered when the gasket is selected.

On narrow flanges, and particularly where internal pressures must be sealed, unit loads on the gasket are very high. This can cause crushing or extruding of the gasket, a tendency that is more pronounced where ambient temperatures are above 200° F.

If assembly methods require screwing a narrow flange into place (on grease guns, for instance), there is a risk of the flange acting like a circular knife, cutting or tearing the gasket material.

A new asbestos gasket—Armstrong Accopac AN-890—has the right combination of properties to provide a seal

This automotive oil filter housing is typical of thin-section flanges that can be sealed economically with Accopac AN-890.

on such flanges. AN-890 is a dense, homogeneous sheet, free of clumps and bunches of fibers. It will withstand crushing and extruding at loads as high as 100,000 psi.

Accopac AN-890 is economical, too. Gauge for gauge, it is 15% to 30% less expensive than conventional compressed asbestos. And in many applications, its high sealing efficiency permits gasket gauge to be reduced as much as 50%.

Our bulletin IND-915 will give you more information on Accopac AN-890. Write for a copy.

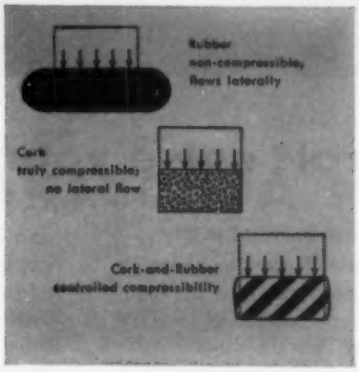
How to cut the cost of O-rings

If you now use molded rubber O-rings, chances are you can reduce costs considerably by changing to lathe-cut rings of Armstrong cork-and-rubber materials. At the same time, it may be possible to effect savings in machining time and inventory costs. Here's why.

Molded rubber O-rings are incompressible and must be made to very close tolerances to insure perfect fit between the flanges. An O-ring too small in cross-section will not seal . . . and an oversize ring will prevent flange contact.

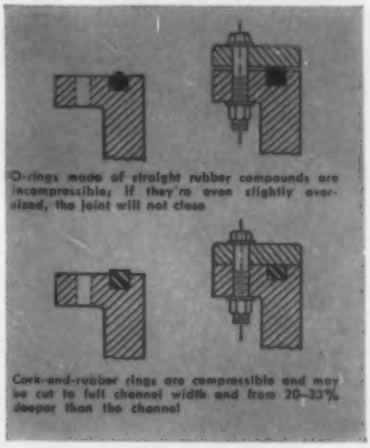
Cork-and-rubber rings help you avoid this difficulty because they combine the compressibility of cork with the non-compressibility of rubber. The per cent of compression for cork-and-rubber rings may range from 20% to 33%.

This compressibility permits wider tolerances in the flanges . . . and can



produce worthwhile savings in machining time. Or it may allow you to reduce inventories by using one size cork-and-rubber ring where two or more molded sizes were needed previously.

In other important characteristics, cork-and-rubber rings behave much the same as molded rings made of the same base polymer. For example, the solvent resistance of a lathe-cut ring made of nitrile-type rubber and cork would be equal to a molded ring made


O-rings made of straight rubber compounds are incompressible; if they're even slightly oversized, the joint will not close
Cork-and-rubber rings are compressible and may be cut to full channel width and from 20–33% deeper than the channel

of a straight nitrile compound.

In such characteristics as heat resistance, imperviousness, and sealing of internal pressures, cork-and-rubber rings will perform just the same as rings molded of the corresponding base polymer.

Armstrong cork-and-rubber rings are available in any size from ⅜" to 20" I.D. Much additional information on designing with Armstrong cork-and-rubber gasket materials is contained in our Gasket Design Manual.

For your copy of the Armstrong Gasket Design Manual, write to Armstrong Cork Company, Industrial Division, 7109 Irvin St., Lancaster, Pa.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

Will this control* solve your problem?

If it doesn't . . . we have one that will!
Today, the many and varied Robertshaw controls are used for every conceivable type of application—from temperature control of cooking ranges to flight controls for the mighty Atlas missile. Robertshaw controls have long been known for their finer, more accurate mechanisms . . . longer trouble-free life . . . and their ability to hold calibration.

So if you have a control or thermostat problem, in any field, why not look to the source of industry's most complete line—Robertshaw. Write for information on your specific needs. Robertshaw engineers are also available to assist you in the application of our controls.

Robertshaw Thermostat Division, Robertshaw-Fulton Controls Company, Youngwood, Pennsylvania.

VMA 6351

**Robertshaw Model D1*

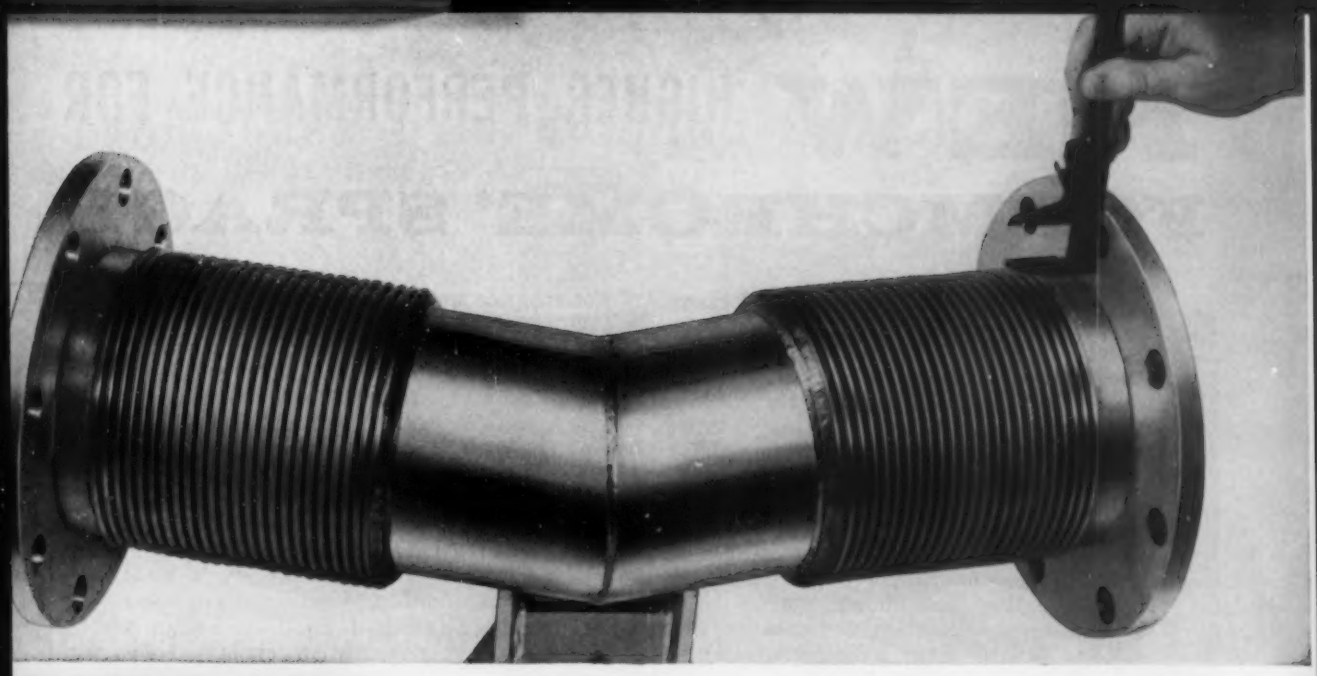
Here are a few of the many characteristics of Robertshaw electric thermostats and controls:

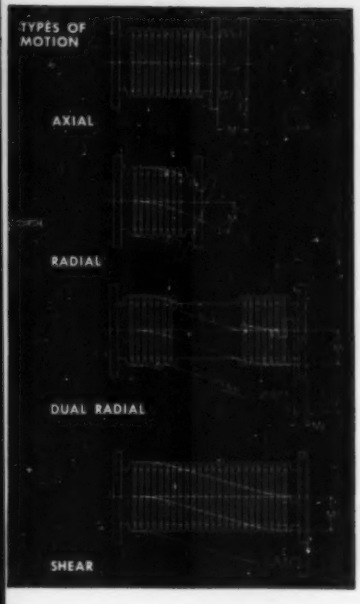
- snap acting or slow make and break
- single or double pole
- direct or reverse acting
- maximum ratings—25A at 250 AC, 15A at 115 DC
- temperatures up to 800° F.
- bulb and capillary thermal element
- stainless steel diaphragm
- case—rugged all steel construction

Robertshaw

MR CONTROLS

CIRCLE NO. 27 READER SERVICE CARD→



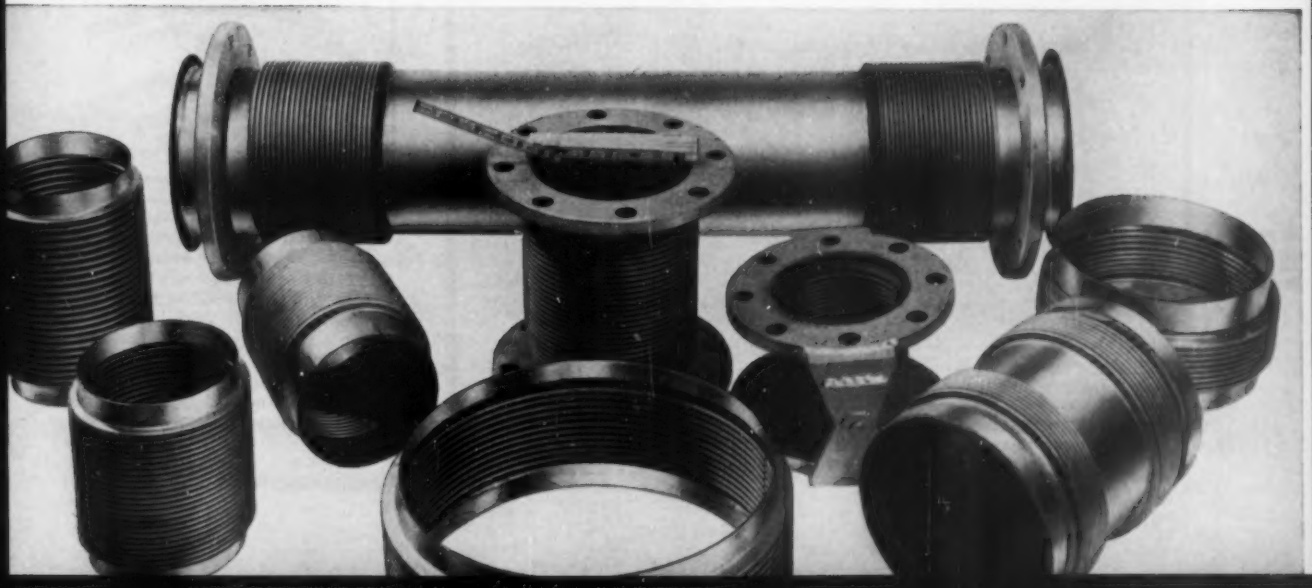


Expansion-joint tubing for big, tough jobs

New AX Tubing by Anaconda is available in Bronze, Stainless Steel, and other metals and alloys—from 4½" I.D. to 14" I.D.—to handle axial and lateral movement.

Need to compensate for contraction of piping suddenly cooled to minus 300°F by a large volume of liquefied gas? Want a bulkhead seal that "gives" with hull movement? Do you need a special assembly like that above, which handles an offset and a combination of lateral and axial movement? Wherever you need large diameter tubing to take care of movement shown in drawing at left, or simple offset, write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 59128

ANACONDA® METAL HOSE



NEW HIGHER PERFORMANCE FOR FORMCHROME* SPRAGS

On over-running clutch applications, Formsprag clutches have always provided greatest torque capacity for size and weight, no measurable backlash, extreme precision and long trouble-free life. Now! With newly designed Formchrome sprags, the best over-running clutches provide users with even higher performance.

Here's why! The new Formchrome sprags are made of hardened high carbon alloy steel with chromium diffused into the surface to form a chromium-carbide alloy. Thus, the sprag is corrosion resistant, and has high hardness and abrasion resistance similar to tungsten carbides. Result—sprag geometry is retained over a longer period and clutches can be used on higher over-running speeds. The Formchrome sprag is exclusive with Formsprag—no other clutch manufacturer can offer you its performance advantages.

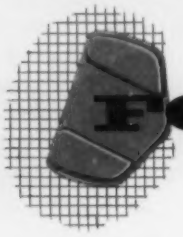
Typical of the higher performance users can now receive from Formsprag clutches is this specific example: A Formsprag clutch using Formchrome sprags was installed in the reaction member of a torque converter and a competitive clutch in another. The competitive clutch showed excessive wear after the equivalent of one year of operation. The Formsprag clutch was run 50% longer and still showed only negligible wear.

There is a Formsprag clutch for every application—from business machines to aircraft. Standard clutches cover a wide range of uses and are described in the Formsprag Catalog . . . send for your free copy. However, to meet unusual requirements, Formsprag engineers will modify a standard clutch or design a special—send your application details.

FORMSPRAG COMPANY
23607 Hoover Road, Dept. 102
Warren (Detroit), Michigan

In Canada: Renold Chains Canada, Limited
In United Kingdom: Renold Chains, Limited
Distributors in Principal Cities

*Formchrome sprags are produced under a patented process. The use of this process in the manufacture of over-running clutches is exclusive with Formsprag.



FORMSPRAG CLUTCHES

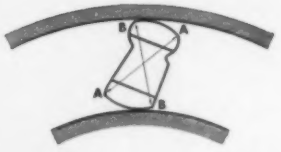
World's Largest Exclusive Manufacturer of Over-running Clutches

TYPICAL APPLICATIONS WHERE FORMCHROME SPRAGS HAVE PROVEN SUPERIOR PERFORMANCE

1. Used in operating submarine missile (Regulus II), Formsprag clutch allows alternator to over-run the hydraulic driving mechanism.
2. Backstop clutch on belt conveyor handling bauxite ore is subjected to higher over-running speed, extreme abrasive dust and hot weather—has been in operation a year.
3. Starter clutch for aircraft ground support system allows high-speed gas turbine to over-run starter unit.

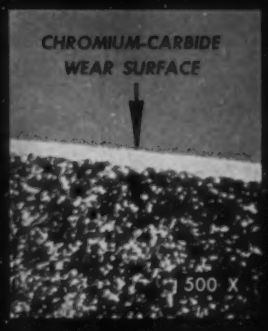
For additional information on how Formchrome sprags assure better performing clutches, write for technical paper "Formchrome Sprags".

HERE'S

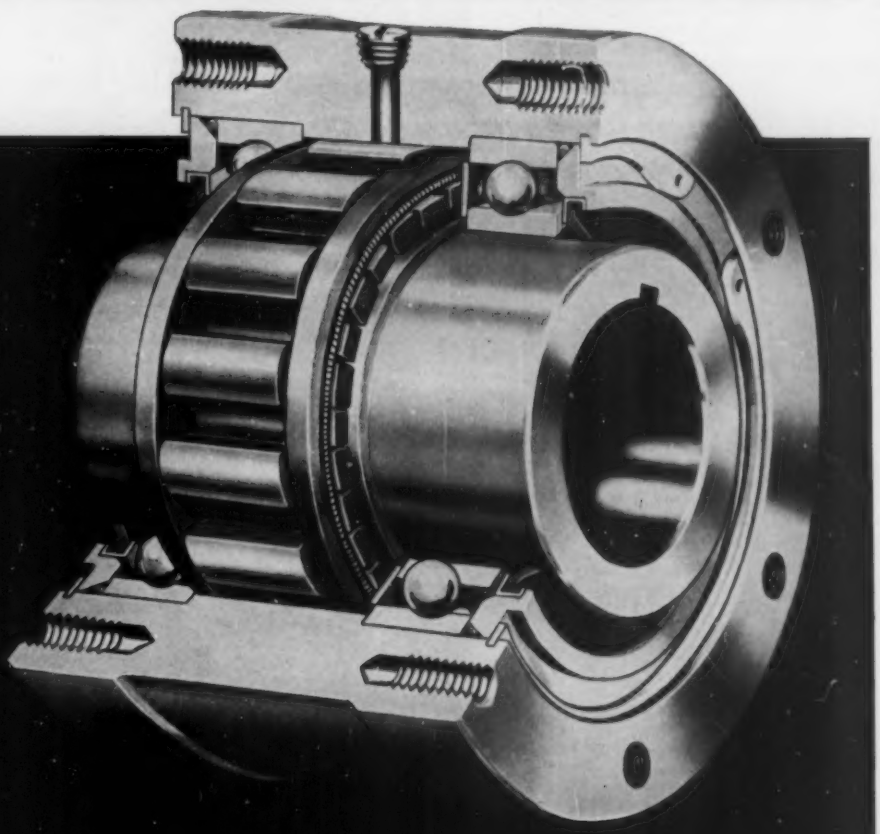


The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

FORMSPRAG OVER-RUNNING CLUTCHES WITH

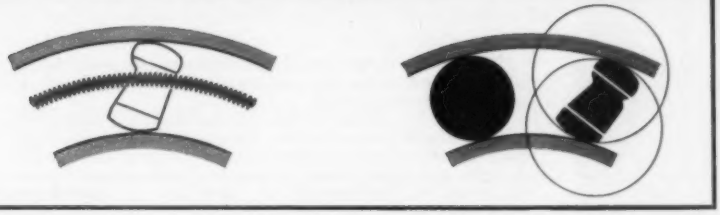


Micro-photo showing chromium-carbide wear surface (1900 Vickers—80 R_c) of Formchrome sprags. Chromium is diffused into high-carbon alloy steel sprag (62R_c).



OVER-RUNNING · INDEXING BACKSTOPPING

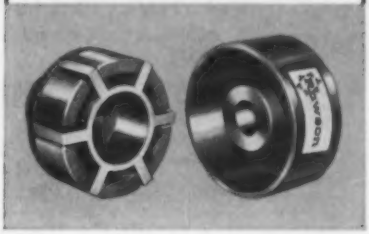
HOW IT WORKS



An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

RAWSON FOR NO-LOAD STARTS

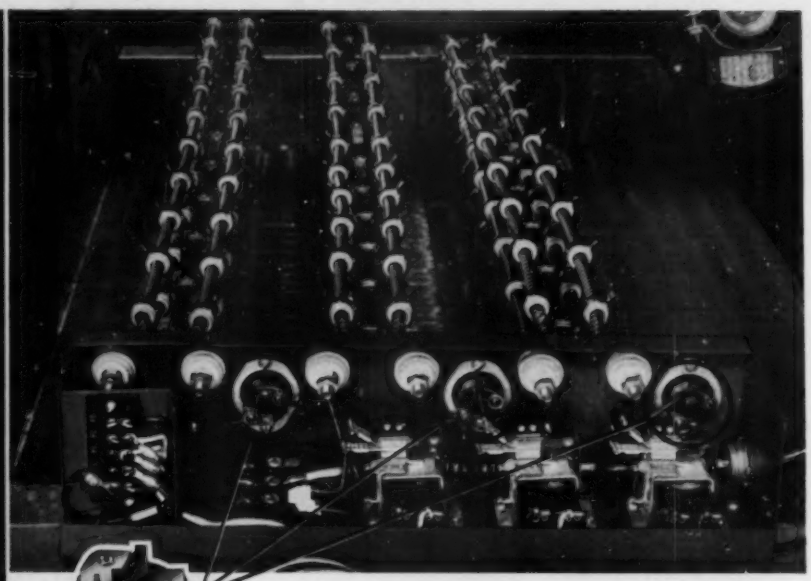


Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.

CIRCLE NO. 29 READER SERVICE CARD 29

YOU CAN BE **SURE**... IF IT'S Westinghouse

Cutaway of the indoor section of the Westinghouse Heat Pump.



View of the auxiliary heating elements showing three KLIXON 202 Thermostats used as temperature-limiting controls.

...And Westinghouse Counts On

KLIXON *Snap-Acting* THERMOSTATS

For Trouble-Free Performance in Their Remote Heat Pump

Cooling in hot weather, heating when it's cold — complete year-round comfort — and it is all done automatically with one modern Westinghouse Heat Pump.

To insure accurate, trouble-free operation of their heat pump, Westinghouse uses *five* KLIXON Snap-Acting Thermostats in each unit. Three are used as temperature-limiting controls on the auxiliary electric heating elements. Another is on the discharge line of the compressor to limit discharge temperature. A fifth KLIXON Thermostat controls a small heater element which regulates compressor oil temperatures to prevent the refrigerant from condensing during shutdown.

Here's what Mr. G. L. Biehn, Air Conditioning Division, says about KLIXON Thermostats:

"Their performance and dependability are evidenced by the fact that this division has used them in various pieces of our equipment for many years."

Westinghouse — another leading manufacturer who specifies and uses KLIXON Controls. Available in both sealed and open construction, these controls are made in a wide variety of types and sizes. Fixed temperature settings are custom calibrated at the factory to meet specific application requirements.

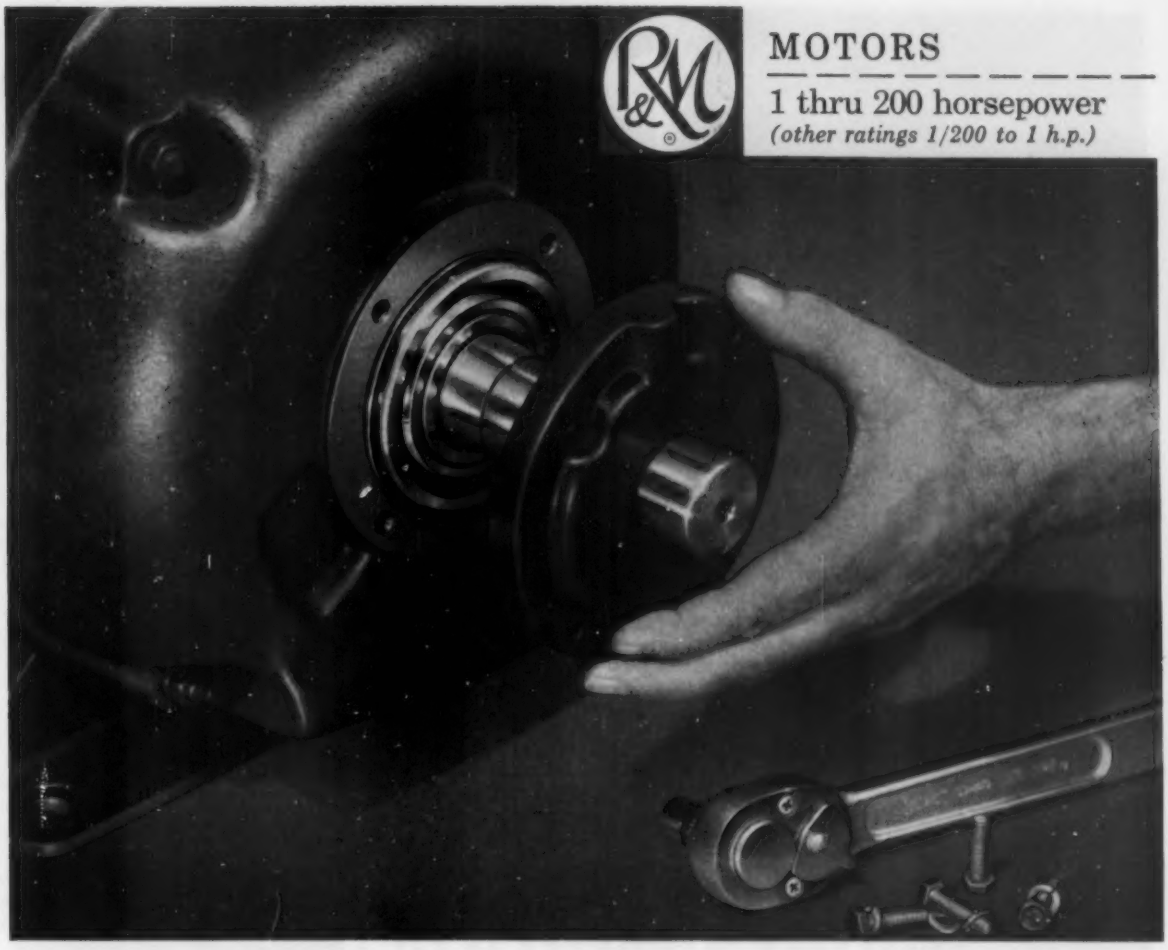
Send details on your control needs, and let us acquaint you with the application possibilities of the KLIXON line. Also, inquire about engineering assistance at no obligation. Write:

METALS & CONTROLS

3809 NORTH MAIN ST., VERSAILLES, KENTUCKY

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

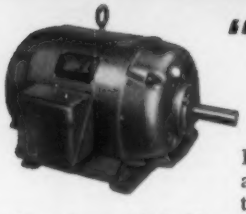
SPENCER PRODUCTS: Commercial Controls Department



MOTORS

1 thru 200 horsepower

(other ratings 1/200 to 1 h.p.)



"On-the-Job" Bearing Inspection and Relubrication are Easy!

ROBBINS & MYERS motor bearings are fully sealed and pre-lubricated to operate for years without attention of any kind. However, when maintenance schedules call for bearing inspection and relubrication at shorter intervals, R&M motors cut downtime and save labor expense by making these inspections easy. The bearing cap on each end head comes off quickly when the four securing bolts are removed. The bearing seal, held in place by removable snap rings, likewise, is easily removed to expose the interior of the bearing.

Easily removable bearing caps are only one of R&M's many desirable design features. Double width bearing races have extra-large grease capacity . . . Mylar* insulation that has 8 times the dielectric strength and 35 times more moisture resistance than ordinary paper insulation . . . end heads offer full-height protection . . . dual-sweep ventilation assures efficient cooling. For details, write today for Bulletin 520 PRE

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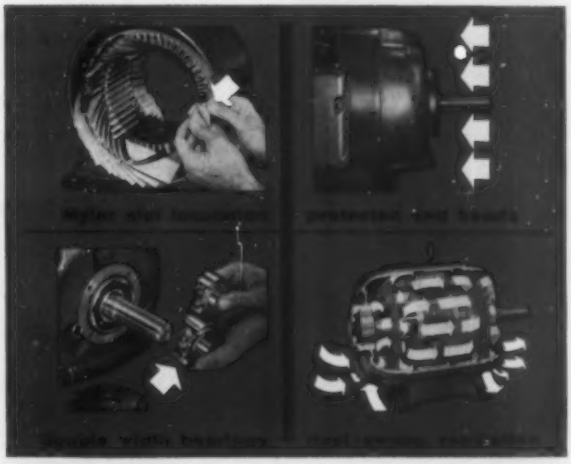

ROBBINS & MYERS, INC.

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CIRCLE NO. 31 READER SERVICE CARD 31

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To assure you of wire cloth fabrications that give long and satisfactory performance, we have experienced engineers who can draw up prints for your approval if necessary, and trained production men who can quickly and accurately fabricate parts to your most rigid specifications.

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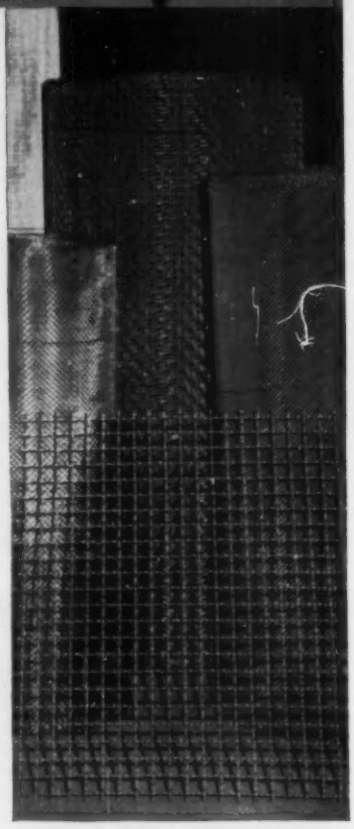
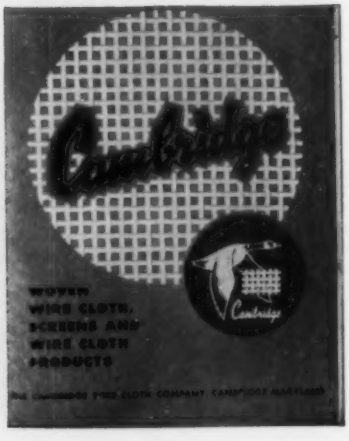
Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications





first in silicones

Dow Corning

SILICONE NEWS

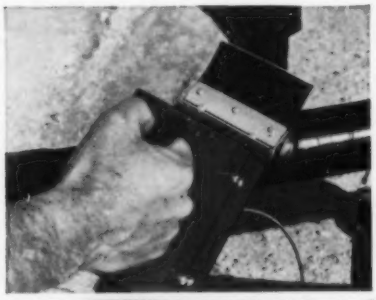
for design and development engineers • No. 66

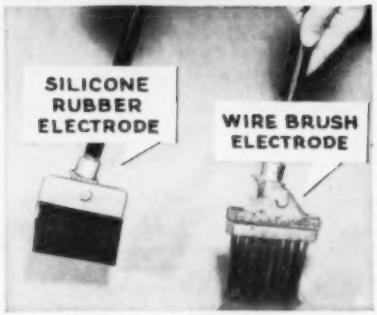
IMPROVE PERFORMANCE; INCREASE SERVICE LIFE

By ingenious use of Silastic®, the Dow Corning silicone rubber, Tinker and Rasor, San Gabriel, California, has made the first major improvement in 20 years in flat electrodes used for holiday or coating flaw detectors.

Designed to reveal pin holes, perforations and bare spots in painted, coated, taped or wrapped surfaces, holiday detectors signal where repairs must be made before extensive damage is done. The operator simply passes the unit's electrode over the protected surface, maintaining intimate contact. When a break in the surface is encountered, the detector converts electrical contact to an audible signal.

Electrodes commonly used in the past were of a wire brush type. These worked, but were far from ideal. They clogged easily when checking tar or asphalt surfaces, required frequent cleaning and replacement; lacked the flexibility necessary to conform to irregular surfaces; and could not be used on thin plastic covering without danger of puncturing the covering.





Tinker and Rasor eliminated these shortcomings by developing a new flexible electrode of electrically conductive Silastic molded on glass cloth. The *(Cont. Pg. 2)*

REDSTONES TO RED HOTS

Heat-stable silicone-based coatings are finding ever increasing use on products ranging from missiles to charcoal ranges. Among the leaders are "Sicon" finishes formulated with Dow Corning silicone resins by Midland Industrial Finishes, Waukegan, Illinois.

Unharmed by temperatures up to 1000 F, these silicone-based finishes provide long-lasting, positive protection against weathering, corrosion and chemical attack. Sicon finishes also retain excellent color, gloss and eye appeal even after extensive aging.

Sicon is applied to the nose cones of Redstone missiles, made by Chrysler Corporation, Missile Division, because this silicone coating possesses the thermal stability to withstand the heat surge generated under simulated re-entry conditions, whereas other finishes ignite and burn.

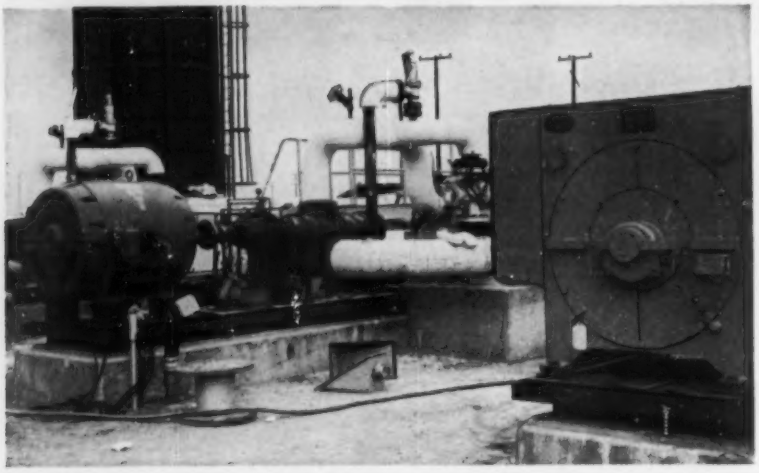
Colored silicone coatings are equally proficient in glamorizing and protecting hot kitchen and patio appliances. The popular charcoal ranges by Hasty Bake Manufacturing Company of Tulsa, Oklahoma, for example, are finished with an attractive Sicon coating that will withstand temperatures reaching 900 F. Under such extreme conditions, this silicone paint not only retains its color and gloss but is resistant to hot grease and weathering.

Other applications for silicone-based finishes: oil burners, mufflers, exhaust stacks, motorcycles, jet engines, boilers, housings, radio equipment, earth satellites, space heaters, home incinerators, radiators and other components and assemblies. What new application can you add to this list? Where can you use a silicone coating to provide protection and help maintain decorative appeal? **No. 241**

Waterproof Leather Boots

Upper leather treated with SYLFLEX®, the Dow Corning silicone for leather. Keeps water out. Lets leather breathe.

Waterproof rubber sole vulcanized to upper by unique process. Moisture cannot penetrate. Sealed seams guarantee dryness . . . More comfort, longer wear. Soft and flexible. For name of nearest dealer, circle . . . . **No. 242**



SAVE ON OUTDOOR MOTORS; SPECIFY SILICONE INSULATION

Dramatic proof of size and weight savings made possible by designing motors with silicone insulation systems is demonstrated by these outdoor direct coupled pump drives at the Alamitos Steam Station of Southern California Edison Company. Here, self-protecting silicone rubber insulation means substantial dollar savings in enclosure cost for the smaller, open frame motor.

Both of the new motors shown in the photo have 400-hp ratings. The difference in weight between the two motors is well over 1,000 pounds. Why is one motor so much larger than the other? Because the smaller Allis-Chalmers motor has a self-protected Silco-Flex insulation system incorporating Silastic®, the Dow Corning silicone rubber. The other motor is insulated with conventional materials.

Despite its much smaller size, the silicone insulated motor also has a 15% service factor not found in the larger unit. This extra cushion against overloads assures greater reliability and longer life for the smaller unit.

What's more, the self-protecting silicone rubber insulation system made possible a reduction in motor enclosure costs. Able to withstand all outdoor elements including flooding, the silicone insulated motor has an open, drip-proof frame. In contrast, the larger motor insulated with standard materials must be fully enclosed in a more costly weather-protected frame. *No. 243*

SILASTIC *(Continued)*

new electrode conducts high voltage electricity and still retains sensitivity at low voltages. It conforms to irregular surfaces and will not mar or scratch even the most sensitive covering. What's more, Silastic is so anti-adhesive it won't pick up coating tar or bituminous materials and requires vitrually no maintenance.

The new electrode retains its shape and conductivity at temperatures ranging from —20 to 450 F — does not soften or become brittle — performs better, lasts longer. No wonder the manufacturer reports that electrodes of Silastic have received enthusiastic acceptance from industry.

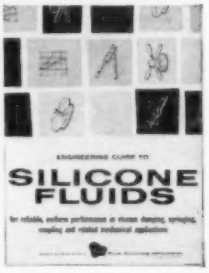
The unique combination of properties that Silastic provides is the reason engineers look upon Silastic as an answer to a variety of design problems. *No. 244*

new literature and technical data on silicones

Selection Guide for Silicone Dielectrics reprinted from Electronics magazine provides a compact, comprehensive table of physical and electrical properties of silicone insulating materials. Cross tabulated, by uses and by physical forms, this handy reference table provides a convenient key to materials most suitable for different design problems. *No. 245*

On the Spot sealing, encapsulating, calking or potting can be done with Silastic RTV, the Dow Corning silicone rubber that vulcanizes at room temperature. Available in several consistencies, ranging from that of calking compound to a pourable fluid, Silastic RTV sets up in minutes . . . forms a resilient solid. Its use in forming flexible molds, waterproofing outdoor electrical connectors, sealing flush access doors or windows of pressurized interiors, as well as many other applications are described in pamphlet form and available to you as . . . . . *No. 246*

Compiled for Advance Research and development engineers, an eight page reference provides a convenient guide to selecting the most suitable silicone fluid medium when designing damping, springing, coupling and related mechanical devices. Includes tables, graphs and detailed information about properties that enable Dow Corning silicone fluids to increase efficiency of existing designs and make possible new design changes. *No. 247*



Design Versatility — Lightweight, strong, inert, and easy to fabricate, silicone-glass laminates are used in the design and manufacture of a variety of consumer and industrial products. Applications, tables of physical and dielectric properties, illustrations of various parts, and sources of silicone-glass laminate parts are included in a 4-page brochure. *No. 248*

Job-proved Dow Corning silicone lubricants readily meet severe performance requirements — help designers solve lubrication problems created by adverse operating conditions. Used on equipment ranging from freezers to core oven conveyors —at temperatures as low as minus 100 F, as high as 500 F. Send for a handy brochure on properties and applications of silicone lubricants. *No. 249*

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DEVELOPMENTS TO WATCH...

Improved lubricants of the solid-film and dispersion type . . .

. . . are promised by studies of gas adsorption by graphite at elevated temperatures, says Acheson Colloids Co. Results thus far indicate that such common gases as air and ozone, applied at elevated temperatures (to 1800 F), can increase particle wettability; while methane treatment has the opposite effect, making the powders definitely hydrophobic.

Says Acheson's R & D manager, Arthur J. Stock: The ability to control the surface properties of graphite powders is a natural step toward the preparation of better lubricants and better dispersions; and it is an area of research which has not been developed nearly as much in this field as it has in paints and other types of pigments.

Embrittlement of cadmium-plated bolts can be reduced . . .

. . . if not eliminated, by proper plating and heat-treating methods, reports from US and Japanese metallurgists indicate.

The Japanese, as quoted by Britain's Zinc Development Association, note that hardness of carburized bolts is increased 100 to 150 Vickers numbers by cadmium plating, and elongation is slightly reduced by the accompanying hydrogen pickup. But, they say, the hydrogen embrittlement can be "eliminated" by subsequent heating to 300 F.

American metallurgists are not quite that optimistic. Reports on research sponsored by Wright Air Development Center say that baking or soaking can relieve the embrittlement to some extent by redistributing the hydrogen; but that "no treatment is successful in eliminating it."

Hydrogen embrittlement can also be reduced by using an aqueous ammonacal plating solution of a non-cyanide cadmium salt, plus an amino-acid addition. But this, too, is only a partial answer.

A new source of erosion . . .

. . . may have been uncovered by G. Lopatin and F. R. Eirich of Brooklyn Polytechnic Institute. They've been studying the adsorption of high polymers on solid surfaces, and find the complex interaction may actually result in robbing or raiding of the solid material by the polymer. As they put it:

"The chelating power of the polymer may be so great as to continually erode the surface." Furthermore, the solvent effects may be such that relatively small changes in the solution will lead to complete alteration of the character of the adsorption.

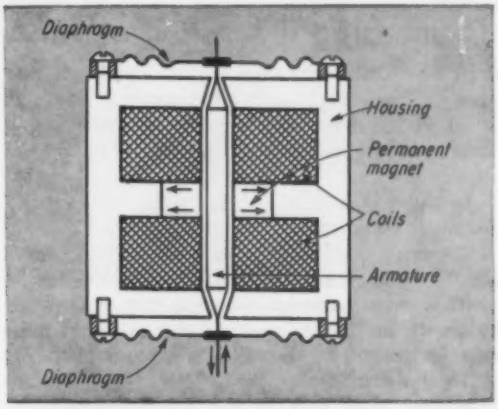
Their suggested remedies: 1. Cycling of adsorption-desorption treatments to condition the surface. 2. Close control of polymer concentration.

A solenoid with linear characteristics . . .

. . . in that the displacement of its armature is proportional to the signal received, has been developed in France.

Features of the device (see diagram) are its annular permanent magnet and its two-part coil. The latter feature makes it possible to use the unit for differential regulation. One part can be energized by the actuating signal; the other is controlled by a signal proportional to the deviation in the system.

According to the French engineers, the force applied to the moving armature will be proportional to the electromagnetic flux at one of the air gaps. Further, if this electromagnetic force is proportional to signal current, it will also be proportional to armature displacement; and, with the diaphragm acting as a return spring, movement of the armature will be proportional to the signal received throughout almost its entire travel. First applications are to hydraulic servomotors for variable-pitch propellers.



French solenoid features annular permanent magnet, with lines of force perpendicular to its axis; and armature actuated by two diaphragms; and two coils, enclosed in a housing that forms the magnetic circuit.

DEVELOPMENTS TO WATCH...

Liquid transition points may be as useful as those in metals...

. . . say J. B. McCoy and L. S. Kowalczyk of the U of Detroit. They've been studying a group of organic compounds that undergo a dual transition: first from solid to cloudy liquid; then to a clear melt. An abrupt change in thermal conductivity has been found to take place at this liquid transition point, just as it does on initial melting. This change, they believe, can aid in selection of liquids for use where specific thermal conductivity is required.

The intermediate or cloudy condition, incidentally, is known as the *mesomorphic* state, and is believed to be analagous to the paracrystalline structure in solids. For this reason, as they pointed out in a discussion of mesomorphism at a recent AIChE meeting, mesomorphic liquids are sometimes known as "liquid crystals."

Porous plastic laminates...

. . . may have greater initial impact strength than conventional solid materials, say J. T. Hill, E. de Vries, and F. Leonard of Army Medical Center.

Bearing strength, bursting strength, and compressive strength generally decrease with increasing porosity. But, they pointed out to this week's ACS meeting, the greatest drop is in the early portion of the curve. As the porosity is increased still further, these properties tend to level off. The AMC researchers believe the presence of pores may actually permit the laminates to yield and be able to absorb greater initial impact than a nonporous laminate. After initial impact, though, the resistance to further stress would likely be lower.

(Note: For more on porous materials, see *PE*—Aug 3, p 24, and Aug 10, p 12.)

High-temperature fuel cells...

. . . are getting a thorough going-over at this week's ACS meeting. While no great break-throughs are promised, researchers from Britain, Holland, and the US report encouraging progress in understanding the mechanisms of the high-efficiency new power sources.

The emphasis is on high-temperature cells, operating at 930 F and above, because, at present, they seem to offer the best hope for utilization of hydrocarbon fuels, as opposed to the costly pure hydrogen now required for normal-temperature units.

As electrolytes for such cells, carbonates are receiving major attention because, G. H. J. Broers of the Netherlands points out; at present, they appear to be the only stable materials available for the job.

As to electrodes, researchers from both Britain and the US believe porous sintered materials—nickel, stainless steel, and silver—look especially promising. Says David Douglas of GE's Research Lab: "The application of gas-diffusion electrodes to high temperature fuel cells offers the possibility of obtaining the large current densities associated with such electrodes in low temperature cells . . . without the high internal resistance, electrolyte contamination, and fragility encountered in magnesia diaphragm cells."

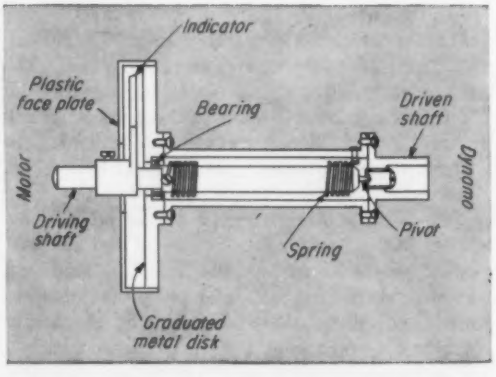
(Note: for more on fuel cells, see *PE*—June 15, P 8, and earlier references.)

To measure the output of very small motors...

. . . Politecnico dil Milano, Italy, has a unit that combines a spring-type torquemeter with a stroboscopic speedometer. It's said to overcome the problems caused by resistance and inertia in other devices of this type.

In the new unit (see diagram), the motor whose output is to be measured drives a resistive dynamo through a shaft, bearing, and pivot arrangement. As the motor turns, a spring attached to the driving shaft is twisted through an angle that corresponds to the torque transmitted, and this angle, in turn, can be read from the dial with a stroboscope.

To minimize friction, the indicator is sealed in the evacuated space between the face plate and the dial disk, and the spring is made slightly larger in diameter than the shaft around which it is wound, and considerably smaller than its housing. —ARG



Spring-type torquemeter couples motor (installed at left) to dynamo with device diagrammed here.

THE ENGINEERING WEEK

Japan's Science Council and Government Dispute Handling of Non-industrial R&D

TOKYO—A bitter battle for control and direction of Japan's non-industrial research and development is going on behind the scenes. The scientific community, led by the Science Council, is arrayed against the government in this struggle. It's being conducted with Japanese etiquette and genteel propriety, but signs of the conflict were apparent this week in a threat by the Council's non-Communist members to withdraw because of "pressure or duties elsewhere."

No one doubts that these members —most of them holding important university and government jobs—are busy, but it's generally believed their withdrawal would be part of a vendetta between so-called conservative and "progressive" forces. The latter often reflect the Communist and left-wing Socialist line. Other developments are these:

• Assumption of duties by the new Science & Technology Commission, a body created in April to coordinate research activities among government ministries. Many observers see the commission's role as an attempt by government leaders—long under Council attack—to sidetrack the Council as the only deliberative body in the scientific community and adviser to government.

• Aggressive attempts by Yasuhiro Nakasone, the volatile, young, new minister of the Science & Technology Agency, to pry loose some research activities of other ministries, particularly Education, and get them into his bailiwick. His agency long as been nicknamed "Atomic Energy Agency" because that is about the only major research activity it has been able to pull under its wing since its creation in 1956.

COMMUNIST ACTION

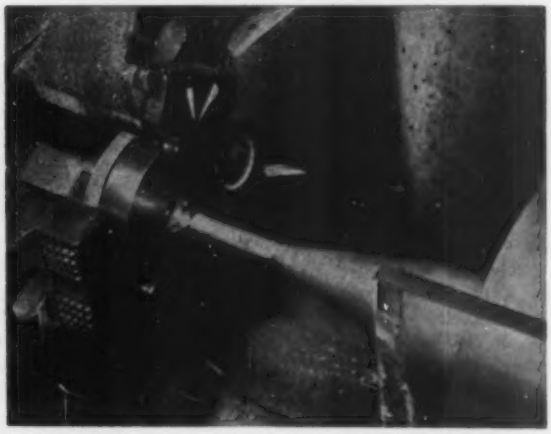
The conflict reveals a cross-section of the entire Japanese scene. Though the Communist Party long ago lost power in Japanese political life and unions, a large body of fellow travelers still take their cue—knowingly or unknowingly—from the International Communist line. Communists' greatest center of power in Japan today is not among workers but among such professional groups as university professors, teachers, writers, actors, etc.—the so-called "intellectual" circle.

Communist-line thinking in Japan's Science Council is an old story. In postwar days Prime Minister Shigeru Yoshida threatened to wipe out this entire group that had been created as "Parliament of Japanese Science." Communists and their friends operate inside the Council through the "Federation of Democratic Scientists." It has connections with the "World Federation of Scientific Workers," a Communist-line outfit headquartered in London.

Japan's leftwingers are largely centered in the physics section of the theoretical-science department, one of the Council's seven branches. They have been consistently opposed by the Council's more conservative medical, agriculture, and especially engineering departments. But they have been disproportionately powerful in council deliberations and publications

Cold-draw Forming Method Solves Tube Diameter Problem

A new forming method for swaging high-strength heat-resistant alloy tubing has been developed by Boeing engineers. The cold-draw technique solves a problem of reducing one end of a 2-in.-dia, 0.01-in. wall M-252 tube down to ½-in. dia. Proposed hypersonic vehicles required 2-in.-dia tubing for structural use and the structural members had to be joined. Ordinary joining methods—welding, clamping, riveting, sleeving—collapsed the thin-wall tubing. To permit any type of joining, wall thickness had to be increased 300%, without increasing over-all weight.



Boeing's solution: a process using nested aluminum tubing (later discarded) to prevent collapse of the superalloy during swaging. Through an 8-stage reduction with interstage anneals, the tube ends are reduced and taped to a 10° angle to ½-in. dia. Reducing the tube size increased wall thickness to 0.033 in., making the tubing acceptable for conventional joining techniques. An alternate process (right), employing a button die, was developed by Boeing researchers for seamless tubing. This entails rotation of a 3-fluted die at about 300 rpm, with tubing is fed in.

because of their superior organization, and the reluctance of engineers to get into heated political discussions.

WILL NOT RUN

One problem of Council politics is elections. There are presently 131,848 affiliates of Council in research and scientific endeavor, who, because of their scholastic achievements and research efforts, are eligible for membership to one of the 210 seats in seven divisions that form the Council body.

A coming election has prompted prominent members to announce they won't be candidates. Among them are present Council Chairman Kankuro Kaneshige, Tokyo Univ professor of engineering and adviser to the Japan Atomic Energy Commission, and Siji Kaya, former council chairman and president of Tokyo Univ. Both deny Council politics is the reason for withdrawing, but newspapers have been speculating why their decision followed creation of the new 8-man Commission of Science & Technology last spring.

This commission follows an American pattern—the President's committee of advisers on science. The prime minister and cabinet ministers of finance, education, economic planning, and science & technology, will be members. The Science Council will be represented by an ex-officio member, its chairman, and by three "experts" to be nominated by the minister with concurrence of both house of Japan's Diet.

Council members, especially leftists, fought creation of the new commission bitterly; giving member status to the Council chairman was government's concession to this feeling. Even some non-Communist members fear that commission represents a retrogressive effort towards overcentralized research, and may stifle criticisms of government policies.

NUCLEAR POWER AND SPACE

But criticism from the Council has sometimes been a little too much for even liberal members of government. This spring, the Council hit hard at the government's Atomic Energy Program, accusing it of bad faith, not using its full effort for the program, and actually thinking in terms of atomic power for military purposes.

The nuclear-energy program has been one of the bitterest bones of contention. Leftist accusations run all the way from citing Japan's sad experiences at the receiving end of atomic weapons, to the more reasonable argument that Japan is overly dependdent on foreign technology and ought to organize its own atomic-energy future. Argument continues that Japan will never achieve maximum industrialization until it cuts its foreign umbilical cord, and since atomic energy is a new field, in which Japanese theoreticians show they have as high capabilities as anyone else, now's the time to start off anew.

Engineers inside and outside the council say this is hogwash. They compare the campaign against atomic energy with the 19th Century refusal of some learned Japanese to allow electricity to enter their homes at the beginning of Japan's modernization. They point out that Japan hasn't the experience, money, or personnel, for the huge research effort needed to get an atomic program of its own off the ground. Furthermore, they say, Japan must profit by being a member of the free-world community with whom its ties are mutual and productive.

It is natural that Nakasone, the new minister of Science & Technology, should be a favorite target of leftists. He's primarily responsible for ramming the atomic-energy commission legislation through Parliament, and is always willing to throw down a gauntlet to leftists in any fight they want. He reportedly is preparing a program for space science which one report says would cost 20 billion yen (about $55 million)—whopping by Japanese standards. That's bound to raise a howl in Council circles, for Nakasone wants the Japanese program to mesh with American research in this field to cut costs, be mutually profitable. Therefore, whatever direction present moves in Council take, there is no doubt that the struggle over what research Japanese will undertake, and who will undertake it, will be a long, loud one. ■

Arabs Seek Engineering but Reservedly

BEIRUT—The 7th Arab Engineering Congress meeting here recently recommended to Arab governments that "foreign engineering be used in Arab countries only to complement the lack of local engineering and scientific knowledge, and not to replace already available Arab capabilities."

The Congress also recommended that Arab governments and engineering societies in Arab states establish groups of consultant engineers in various fields of engineering, available to any Arab country on demand.

Nearly 700 engineers from Lebanon, the United Arab Republic (Egypt/Syria), Kuwait, Saudi Arabia, Iraq and Jordan participated in the Congress which took place at UNESCO City in Beirut. More than 50 papers were read in 5 committees. The committees were: planning and technical mobilization, housing projects, communications, agricultural, mining and industrial development.

These committees recommended that Arab governments unify their power utilization programs; undertake photogrammetry in drawing up topographic, geological, and agricultural maps of Arab lands; give preference to highway projects which are part of the Pan-Arab Highway Project already approved by the Arab League; use vehicle duties to improve the state of roads in Arab states; standardize their measures and symbols; and set up bureaus of standards, long-term housing policies, etc. ■

British Up Automation by 9% in Industry

LONDON—Statistics released by the Board of Trade here show definite progress toward automation in British industry. Deliveries by makers of instrumentation and industrial-control equipment have increased 9% between 1956 and 1958, compared with no net change in total industrial production and an increase of only 1% in total manufacturing.

The statistics are based on reports of appropriate sections of the optical instruments, electrical measuring instruments, electronic computers (including office machinery), control instruments, and other scientific and industrial instruments industries. Defense purchases were excluded. Exports of this type of equipment showed the same increase during the period.

Suspension System Highlights

INNOVATIONS IN 1960 TRUCK LINE

DETROIT—A completely new suspension system for front and rear is highlight of the 1960 Chevrolet truck line. Design here, says General Motors, sets new standards for truck stability, durability, driver comfort, and load cushioning under present conditions of increasing horsepower, heavier payloads, and modern high-speed highways.

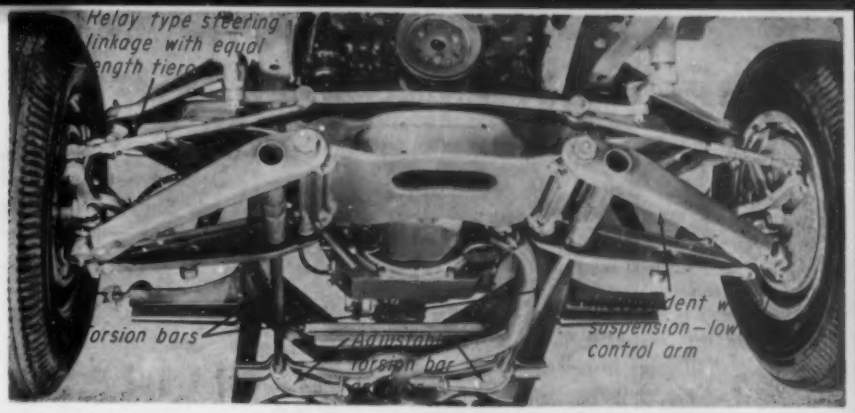
The new line pioneers independent front-wheel suspension with ball joints and torsion bar springing; and on light-duty models, a two-link coil spring rear suspension. Variable-rate, two-leaf-spring rear suspensions are new on models rated at 2 tons and up. Frames, steering, and other chassis components are tailored to complement the new suspension.

FRONT SUSPENSION

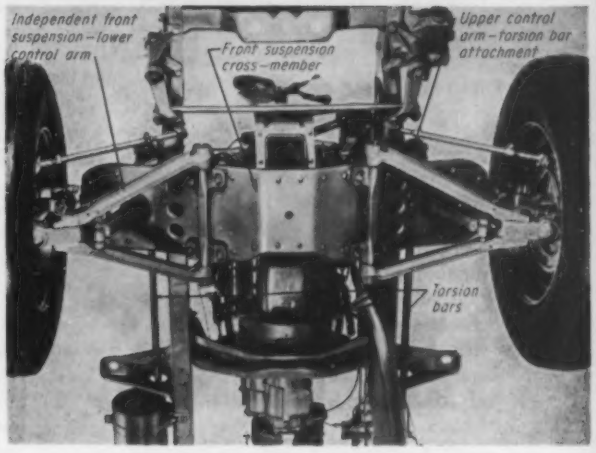
Torsion bar springing was designed in for a softer ride and better stability. This is claimed superior to leaf springs, which need a minimum load to overcome friction between the leaves before the spring becomes effective.

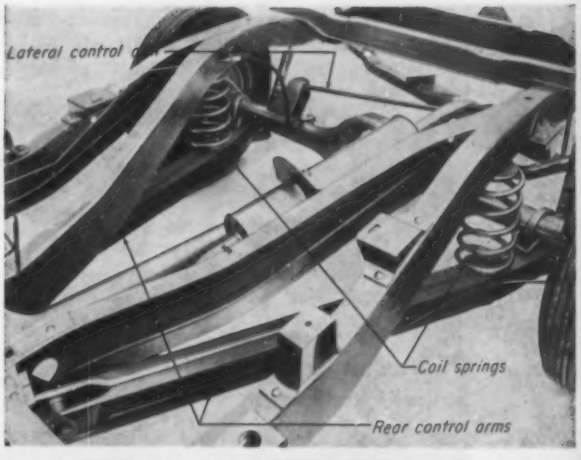
Improvements in vehicle safety are inherent. Normally, a spring failure

(Continued on Page 40)

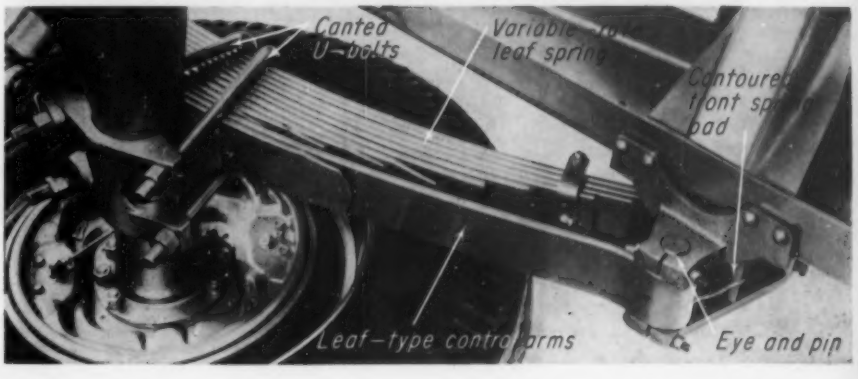


Front suspension features . . . individual torsion bar springing of the wheels. Light-duty model (above) has bar welded between fore and aft sections of the lower control arm. Anchor at rear is attached to a lever arm suspended from a crossmember by an eyebolt to allow adjustment. For medium and heavy-duty trucks (right), forward bar attachment is to upper control arm. This brings it back horizontally along the frame rail to a fixed anchor. Since forward anchor is in center of control-arm pivot, no bending forces are imposed and a fixed anchor can be used.





Rear suspension uses coil or leaf springs . . . depending on the model. In light-duty series (right), fore and aft thrust and rotational torque are absorbed by steel channel control arm running from outer ends of the axle housing to an apex near center of the X-member frame reinforcement. Tranverse forces are absorbed by a lateral control arm attached to the right-axle housing and running laterally to the left frame rail. With control arms taking all driving and braking forces, springs with low deflection rate are used for softer ride. Medium and heavy-duty series (below), use a spring pile with no shackles, bushings or pins at the ends. Under the spring, and separated from it by a short spacer, is a leaf-type control arm which fastens to the spring hanger with an eye and pin. Arm absorbs all driving and braking thrusts, leaving the spring free to cushion the load. Canted U-bolts increase effective spring area at axle attachment point.



affects steering; the new suspension has rigid control arms to maintain front members in position and alignment in event of spring failure. Also, resistance to sway or roll on turns is better because effective spring centers have been moved outboard to point of tire contact with the road.

Ball joint suspension gives built-in friction for better ride, good wheel return, and automatic take-up for wear, as well as reducing weight and simplifying lubrication.

REAR SUSPENSION

Two-link coil springs in conjunction with control arms give greater resistance to roll and sway, better control on turns because of built-in understeer, reduced unsprung weight, and improved part life and suspension durability in the light-duty models.

Replacement of compression type shackles with tension type, changes in shackle angle, revised spring camber and leaf stress levels, and shortening of some secondary leaves—these are factors substantially improving ride, control, durability, and handling in the medium and heavy-duty trucks.

On the big trucks, the upper leaf rides free against a contoured pad in the fore and aft hangers. At curb weight only the upper section of the spring is in operation. As load increases and deflects the spring, leaves tend to level out from their cambered position. Effect is to move the contact point inward along the spring pile towards the center where spring rate is highest. Shortening of effective spring length may be as much as 9 in. ■

US Machinery to Build Soviet Plastic Pipe

NEW YORK—A million dollars worth of machinery for the manufacture of plastic pipe will be shipped to Russia following issuance of an export license to Omni Products Corp. When installed, equipment will be capable of turning out 20 million lb/yr of rigid and flexible pipe.

Omni officials stated the exports would only be manufacturing machinery and not the raw materials needed for the process. Russian-made plastics will be used, they said, probably polyethylene for flexible piping, and polyvinyl chloride for the rigid pipe. ■

Department of Defense Appropriations by Service and Functional Categories

	Enacted 1959	Budget Request 1960	Enacted 1960
	(in millions of dollars)		
By Service			
Army	9,052	8,985	9,376
Navy	11,480	11,108	11,007
Air Force	17,982	17,767	17,473
Office of Sec'y Defense	1,374	1,388	1,373
Total DOD	39,888	39,248	39,228
By Title*			
Military Personnel	11,809	11,625	11,638
Operation & Maintenance	10,055	10,503	10,437
Procurement	15,264	13,348	13,336
Research & Development	2,760	3,772	3,817
Total DOD	39,888	39,248	39,228

* New budget title adopted by Congress

DOD's Budget Has Its Ups and Downs

WASHINGTON—Defense Department's 1960 appropriations amount to $39,248,000,000—a net decrease of $20-million from the President's budget request (see chart). But changes made by Congress were numerous—increases amounted to $909,600,000; decreases to $929,561,000. Here's a breakdown on engineering-project changes:

- Increase for nuclear powered carrier – for long lead-time procurement items. President requested $260 million for a conventional aircraft carrier. The House deleted it. Senate, however, added $380 million for construction of a nuclear powered carrier, but a joint committee provided only $35 million at this time for advanced procurement of some items.
- Atlas ICBM program additional procurement funds of $35 million to provide a down payment on additional squadrons. Substantially more funds in subsequent years will be required.
- Minuteman ICBM program—$87 million for acceleration of research and procurement phases of the project.
- Decrease for jet cargo aircraft—deletion of funds for 10 aircraft for a total of $53.3 million.
- Safety-of-flight modifications – $50 million reduction of funds, in the belief that amounts requested were excessive.
- MACE—deletion of $127.5 million for procurement of MACE ground-launched tactical missiles.
- Bomarc—$82.8 million reduction of the antiaircraft-missile program. Radar improvement program—$50 million reduction for replacement of existing radars with improved radars having a longer range capability.
- Nike-Hercules—reduction offered by DOD of $10.8 million in presenting the revised Air Defense program. ■

Lawmakers Go Slow On Metric Change

WASHINGTON—Two bills introduced in Congress, one in the Senate, the other in the House, call for a study of the practicability of making it mandatory to use the metric system in the US. The bill introduced by Sen Richard L. Neuberger (D-Ore) was referred to the Senate Interstate and Foreign Commerce committee. In the House, Rep Overton Brooks (D-La) introduced a similar bill and it was referred to the House Committee on Space and Astronautics. Neither committee has taken any action on the bills and none is expected this year. Bills introduced this year, however, are carried over to next year's session, so they aren't dead yet. Neither carried any specific dollar apportions, stating only that study money should be made available. ■

Magnetic-pinch Plasma Engine Intrigues Gas Experts

CHICAGO—Description of a magnetic-pinch plasma engine highlighted the third Gas Dynamics Symposium sponsored by the American Rocket Society and Northwestern Univ. Dr Theodore Von Karman opened the symposium with optimistic predictions: harnessing thermonuclear power in 10 years, and achieving specific impulses of 10,000 to 20,000 sec from practical, plasma, space-vehicle propulsion systems within 20 years.

Dr Von Karman also outlined three areas of magneto-fluid dynamics which appear most promising: flow modification containment of hot plasmas, and space-vehicle propulsion.

Special attention was paid to astronautics during the symposium. Although the 21 presented papers centered on plasma physics, magneto-fluid dynamics and power generation, all dealt with space vehicle applications.

PINCH-PLASMA ENGINE

Attracting most interest during the session was the paper presented by Alfred E. Kunen and William McIlroy, both of the Republic Aviation Plasma Propulsion Laboratory. It described an electromagnetic pinch-effect engine that could propel a 35,500-lb vehicle from an earth orbit to a Mars orbit in approximately one year; exhaust velocity would be about 46.9 kilometers per sec (153,832 fps).

The engine, originally conceived for interplanetary vehicle propulsion, and now being developed by Republic, has a more immediate application in the control of satellites.

Kunen, manager of the project, said the low-thrust engine could be used to power satellites in orbit; using the plasma engine, a satellite could: (1) prevent tumbling which interferes with telemetry and reconnaissance abilities; (2) stay in orbit longer by overcoming the drag produced by space dust, now known to be more dense than previously estimated, which slows satellites and shortens their life considerably; (3) change orbit (impossible without on-board power) to compensate for original firing inaccuracies; or (4) move to a different orbit requiring a different velocity.

The plasma engine described by Kunen would provide a 5000-sec specific impulse and use 460 kw of electrical power. Kunen said this engine would be ideal for satellite control because of its extremely low fuel consumption and consequently reduced fuel weight. Very little mass flow is necessary because the engine ejects plasma with high velocity — 100,000 to 150,000 fps.

Development of the engine is one of several projects now underway in a $35-million (Republic's money) astronautics research program at Republic in Farmingdale, L. I. ■

Encourage HS Students Towards Engineering

ZURICH, SWITZERLAND—Vocational courses for highschool students have been organized by the leading Swiss concerns, Gebrueder Sulzer AG, Swiss Locomotive and Machine Works Ltd, and Jac. Rieter Ltd, all in Winterthur. Courses are recognized by the Swiss Institute of Technology and credited as part of the compulsory vocational practical courses required of all engineering students.

Firms hope to secure future personnel by encouraging the highschool students towards engineering careers. Students are paid by the firms, $50 for the four weeks they are employed.

They work in different departments of the plants and learn the basic principles of forging, welding, casting, woodwork and sheet metal fabrication. Lectures, by shop personnel and engineers, are part of the program. ■

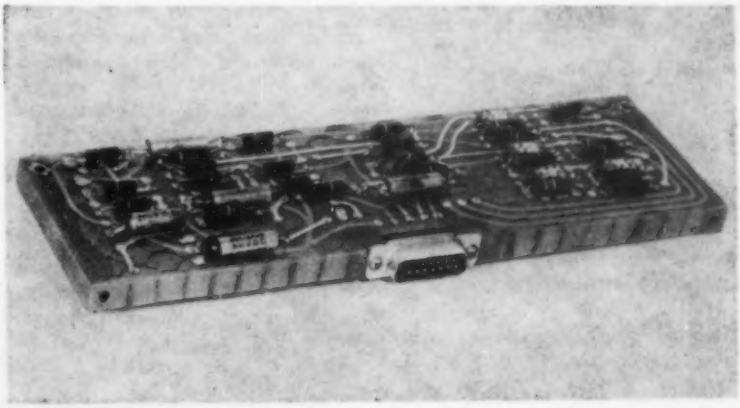
Honeycomb Beefs Up Printed-circuit Panels

PHOENIX, ARIZ. — Plastic electronic-circuit panels using a reinforced fiberglass honeycomb core have been developed by Motorola Inc's Military Electronic Div.

According to Motorola engineers, the honeycomb core—a series of reinforced fiberglass cells bonded together—is particularly suitable as a support for electronic circuitry used in certain airborne missiles because of its strength, lightness, temp resistance.

Moreover, the core (made by Hexcel Products Inc, Berkeley, Calif) permits engineers to use ultrathin printed facings (0.015 in), which simplifies solder connecting circuitry through facing. The core's open cellular construction also allows locating circuitry on inside of the panel. The core also provided good support for an edge-mounted multipole jack with integral, interior-protected connections to circuitry on the inner skin surfaces.

In addition, the bonded assembly was found to withstand most severe



Fiberglass is the core . . .
This panel measuring 9 by 3½ in. is constructed with 0.015-in. fiberglass-reinforced epoxy. Heat-resistant plastic honeycomb is ⅜ in. thick. Printed circuitry is applied on inside and outside surfaces of both facings. Bonded assembly was tested with 5-g loading repetitively applied (sinusoidally) at frequencies from 0 to 700 cps.

test conditions. For example, it remained rigid under 4-point corner suspension at temperatures ranging from −48 F to 160 F, while continuously subjected to heavy acceleration and vibration.

Success of this application, reports Motorola, has resulted in design of several other assemblies using honeycomb core construction. ■

COMING EVENTS

SEPTEMBER

17-18 . . . . American Society of Mechanical Engineers, American Society of Electrical Engineers, 7th Annual Engineering Management Conference, Statler-Hilton, Los Angeles, Calif.

20-25 . . . . Instrument Society of America, 14th Annual Conference and Exhibit, Chicago Amphitheater and downtown hotels, Chicago, Ill.

20-23 . . . . American Society of Mechanical Engineers, 14th annual Petroleum Mechanical Engineering, National Conference, Rice Hotel, Houston, Texas.

21-22 . . . . Steel Founders' Society of America, 57th Fall Meeting, The Homestead, Hot Springs, Va.

21-22 . . . . Standards Engineers Society, Eighth Annual Meeting, Hotel Somerset, Boston, Mass.

22-24 . . . . Armour Research Foundation and NUCLEONICS magazine, Industrial Nuclear Technology Conference, Morrison Hotel, Chicago, Ill.

23-25 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 4th Annual Special Technical Conference on Non-linear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D. C.

23-25 . . . . Office Equipment Manufacturers Institute, Business Equipment Exposition, National Guard Armory, Washington, D. C.

28-Oct. 1 . . . . American Welding Society, Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

1-2 . . . . Society of the Plastics Industry, Fifteenth New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

26-28 . . . . Office of Naval Research, First International Symposium on Gas Lubricated Bearings, Shoreham Hotel, Washington, D. C.

Technical Men Urged to Rally Public Opinion Against A-tests

LOS ANGELES—A Nobel Prize man is urging scientists and engineers to get the help of society as a whole in establishing a ban on the making and testing of nuclear weapons.

In an exclusive interview with PRODUCT ENGINEERING'S Los Angeles editor, Prof Linus Pauling, winner of the Nobel Prize in chemistry, urged the world's technical community to alert its fellow citizens to the dangers of bomb-testing fallout.

Recently returned from a 2½-month world tour, Pauling strongly criticized mere discussions of the "dangers" and "hazards" of further nuclear testing. "The explosion of nuclear weapons does not create a hazard . . . the word 'hazard' leaves an element of doubt. Let's face it. Nuclear bombs create definite damage.

"My estimate is that, over a long period of years, more than a million children will be borne with gross physical or mental defects caused by the radioactive carbon from bomb tests carried out so far. My estimate is that about one million cases of cancer will be caused by radioactive fallout."

Pauling explained that a principal danger is from strontium 90, which is absorbed into plants and grazing animals and finds its way into the bones of growing children. There it subjects the bone marrow to harmful radiation that causes bone cancer and leukemia. Pauling feels the US government should take immediate action to discover the best way of minimizing Sr-90 absorption. One suggested method is adding Sr-90-free calcium compounds, derived from mineral sources, to foods. Since the body cannot discriminate between strontium-containing calcium and strontium-free calcium, doubling the calcium content of foods could have strontium absorption. ■

Application of Scientific Findings in US 'Slow as Molasses,' ASME Reports

NEW YORK—A program to chop "the dangerous time-lag" between scientific discoveries and their practical application is being urged by The American Society of Mechanical Engineers. Such delays constitute "our greatest single handicap in competing with Soviet and other state-controlled industry," said Glenn B. Warren, president of the 50,000-member ASME. He named Fenton B. Turck, a leading consulting engineer of this city, to organize efforts to speed application of new scientific knowledge.

"Half the billions we pour into scientific research are wasted until we discover how to shorten the science pipeline to the American people. The flow of scientific findings to industry now runs like molasses.

"Scientists must think more in terms of putting their discoveries to work. And engineers must be more alert to use improved products and techniques," Turck said.

He will enlist heads of industrial concerns, leading engineering and scientific educators, prominent engineer and research foundations to help discover means of speeding transmission of new information from laboratories to the factory floor.

Mr. Turck stated, "Examples are legion. There are a whole flock of new metals—'wonder metals'—that we've developed, but haven't yet put to work. Cadmium, magnesium, barium, titanium and beryllium offer tremendous possibilities—when engineers finally 'discover' them. The physical theory of nuclear fission was well known to scientists for years before engineers built the plants that produced practical quantities of uranium and plutonium.

"Despite the fact that we have thousands of publications, conferences, symposia, technical digests and other media of communication, some discoveries are left on the shelf for long periods of time while industry operates with inferior techniques." ■

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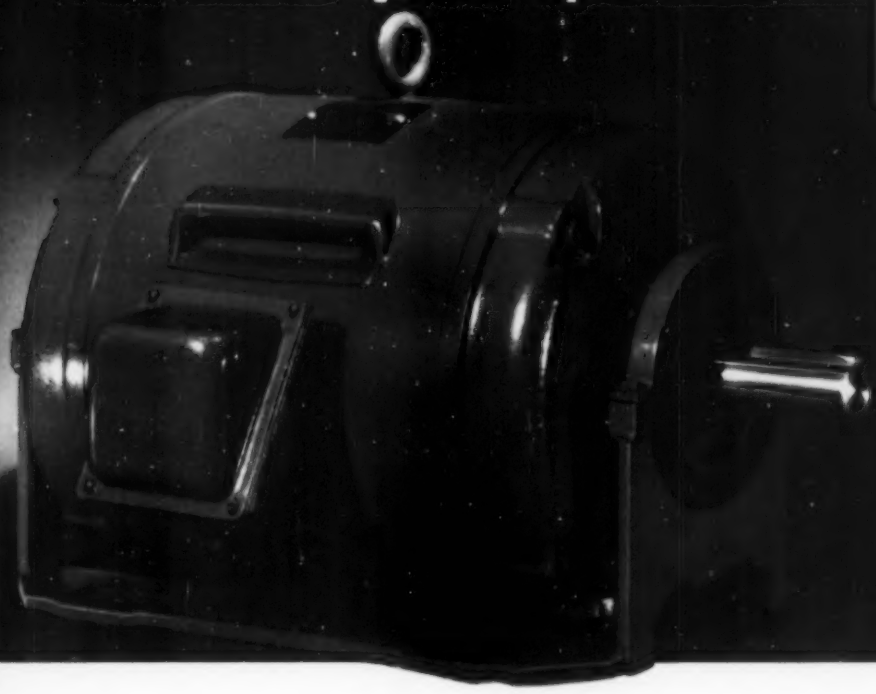
For *extra quiet* operation...



WAGNER 10 HP RESILIENT MOUNTED MOTORS

are vibration free··sleeve or ball bearing

Today, many motors are installed in areas where noise must be held to a minimum — in hospitals, churches, schools, office buildings, restaurants and similar locations where quiet is essential or desirable.

Such installations have created a need for larger polyphase motors that are exceptionally quiet and vibration-free. Wagner has filled this need by expanding its line of polyphase resilient mounted motors to include standard ratings through 10 hp.

If you have an application that calls for a smooth running motor, cushioned by resilient mountings, it will pay you to specify these Wagner Motors—a complete range of ratings from 1 through 10 hp.

Constant research and development have kept Wagner up front in electric motor design for more than 65 years—made the name Wagner one you can trust in choosing electric motor drives.

Your nearby Wagner Sales Engineer can help you select the *right* motor to meet your requirements. There are Wagner branch offices in 32 principal cities.

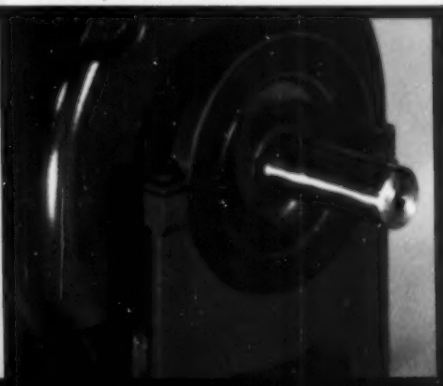
Wagner Electric Corporation

6400 PLYMOUTH AVENUE, ST. LOUIS 14, MISSOURI

SLEEVE OR BALL BEARING. **These motors are furnished with quiet running steel-backed babbitt lined sleeve bearings that have high load carrying capacity. Ball bearings can be supplied when desired.**

NEOPRENE CUSHIONING RING. **Annular mountings, of neoprene bonded to steel rings, cushion the motor in its cradle base to absorb the small amount of vibration that remains in the most carefully balanced motor.**

CEILING, SIDEWALL OR HORIZONTAL MOUNTING. **You can mount these motors on walls or ceilings by rotating the cradle base 90° or 180°. The motor is designed to remain completely dripproof in any horizontal position.**



Pack MORE POWER Into LESS SPACE

WAGNER CAPACITOR-START MOTORS

PROVIDE DEPENDABLE STARTING . . . GIVE LONG TROUBLEFREE SERVICE . . . OPERATE IN ANY POSITION

Here's the single phase general purpose motor that gives quick troublefree starts every time—thanks to a Wagner-designed quick break switch . . . that has earned the Wagner motor reputation for giving long troublefree service . . . that permits all angle operation in sleeve bearing fhp models.

Wagner Type RK Motors give more horsepower with less bulk —are ruggedly built to permit direct mounting—are small enough to fit in tight spots. Available in a range from ⅛ through 5 horsepower, with either sleeve or ball bearings, with rigid bases or with resilient mountings for exceptionally quiet operation.

You can get these motors from leading motor distributors in your community or through Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details on Capacitor-start Motors.

Wagner Electric Corporation
6400 PLYMOUTH AVENUE, ST. LOUIS 14, MISSOURI

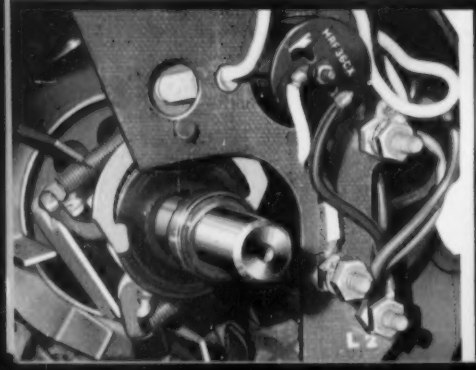
WM59-11

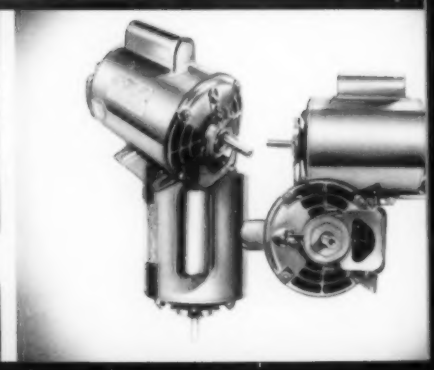
QUICK BREAK SWITCH. The starter is disconnected from the line by this Wagner-designed switch—test proved to make more than a million breaks. (That adds up to two starts per hour for 50 years!)

MYLAR* INSULATION. Mylar-paper insulated slot insulation gives excellent protection against moisture, adds thermal stability that gives these motors longer life when unexpected overloads occur.

*DuPont Trademark

ALL-ANGLE OPERATION. The sleeve bearing design, in fractional hp ratings, has a positive lubrication system that permits operation in any position . . . can mean important savings in motor costs to manufacturers.





8 *steps to better engineering writing...*

1.. VANITY AND LAZINESS, BE SIMPLE
2.. BE POSITIVE, BE BRAVE
3.. BE PERSONAL, BE SPECIFIC
4.. BE CONCISE, DON'T OVERSTATE
5.. VOCABULARY, GRAMMAR, PUNCTUATION
6.. TABLES, FIGURES, CAPTIONS
7.. WHERE TO PUT WHAT
8.. SIT DOWN AND WRITE

RICHARD M. KOFF, *senior associate editor*

Lesson.. 2

Good writing is rarely achieved in the first draft. This is true for a good business letter or engineering report as much as for a famous play or novel. But, in industry, revision is out of fashion. The current image of a big business executive is a man who can dictate to four secretaries simultaneously and close a couple of million-dollar deals on the telephone between paragraphs.

When executives try to live up to this image, their letters are bad. Because they are stereotyped, ("We are in receipt of yours of the 10th inst . . ."), if not rambling and incoherent. An acceptable, dictated letter takes careful planning (expert letter writers often make extensive notes before calling for the secretary). A stock of graceful phrases will help tide you over the awkward places.

Our first rule about simple sentences (subject, verb, object) and unadorned nouns and verbs will cover you in most short (one-page) letters. But longer reports and letters simply cannot be dashed off in this way—not even by professionals. When you have to communicate more than just yes or no or "Why don't we have lunch together some day?", then standard phrases and dictation from notes won't get you off first base. You can dictate the first draft, but that's all it ever will be—a rough draft—needing revision after revision before it will say what you want it to, economically and understandably.

So this is a plea for the brutal art of rewrite. We started last week by editing a few complex, inverted sentences into shorter, more-logical form. Even the best writers produce sentences of that kind in their first drafts. Impatience, laziness, the press of other demands on your time, will tempt you to stop there. The result is poor writing, poor reader impressions, and misunderstanding.

THE SECOND RULE

A close corollary to the "be simple" rule is a second which says, "Be positive, be brave." Sounds like a Middle Ages injunction for knights-errant, doesn't it? But it applies to modern-day writing—particularly to that written by engineers and scientists who, in their written communications, are the worst cowards of our generation. For example:

> Under certain conditions of temperature and relative humidity, the moisture content of the air seems to tend to increase the likelihood of oxidation of iron and certain iron compounds when exposed to these atmospheres.

(Iron will rust in damp atmospheres.)

In an attempt to answer all possible critics the scientific writer modifies his words with "almost, very, maybe, tends to, etc." until the nouns and verbs are covered with a meringue of modifiers.

Nothing in life is absolutely so. You don't have to make this point in every sentence you write. The reader has lived; he knows the risks in crossing busy intersections. Give him your ideas bravely and let later paragraphs, or his own experience, supply the modifiers.

Bravery also implies a positive attitude toward life. Avoid statements which are intended to describe by exclusion or to damn by faint praise. If you wish to damn, damn in so many words. If you think a theory or a person has disadvantages, say so. Don't dwell on the lack of virtue.

> Long bearing life cannot be expected in dust-laden environments.
> Dust destroys bearings.
> Weather predictions are not likely to be as reliable as one might wish.
> Weather predictions are unreliable.

Here are five cowardly, negative statements made by engineers. Can you rewrite them in shorter, braver statements without altering the meanings?

1 . . We do not think the proposed gear-tooth design can carry the specified load.

2 . . An inspection of the production run seems to indicate there is a not very careful lathe hand somewhere in the shop.

3 . . We don't have much hope for the mathematical model proposed by Mr Smith.

4 . . The coating can hardly be expected to stand up under salt-water spray.

5 . . No invention resides in adding means to make a device movable when, without such means, the device would not be movable.

1 . . The gear teeth are too weak.

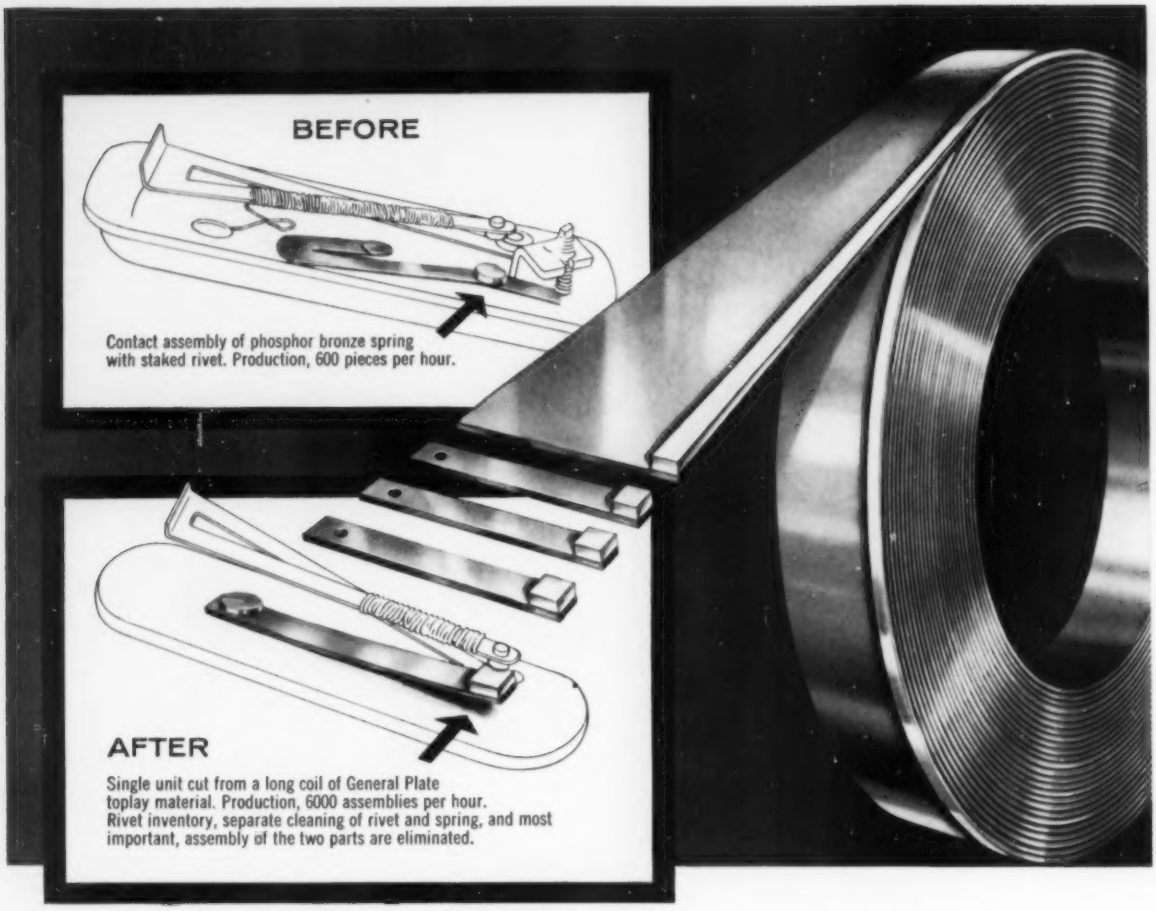
2 . . A sloppy lathe hand is messing up the production run.

3 . . Mr. Smith's mathematical model won't work.

4 . . Salt spray will destroy the coating.

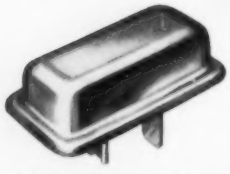
5 . . Making an immovable object movable is not invention.

***Reprints** of this series will be available at the end of October. To reserve your copy, Circle or write in No. P15 on the Readers' Service Card.*


BEFORE
Contact assembly of phosphor bronze spring with staked rivet. Production, 600 pieces per hour.
AFTER
Single unit cut from a long coil of General Plate toplay material. Production, 6000 assemblies per hour. Rivet inventory, separate cleaning of rivet and spring, and most important, assembly of the two parts are eliminated.

GENERAL PLATE TOPLAY MATERIAL ENABLES KING-SEELEY CORPORATION TO

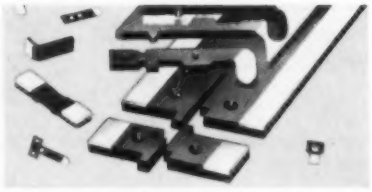
Increase Contact Assembly Production 900%



Recently King-Seeley Corporation, long a leading manufacturer of instrument panel gauges and other automotive equipment, redesigned the contact assembly in the constant voltage "CV" voltage regulator, a component of their constant voltage gauge systems. The old design called for blanking of a phosphor bronze spring, cleaning and finally staking of a General Plate rivet. By changing to General Plate toplay contact material the operation called for simply cutting off and cleaning. Expensive assembly operations were eliminated. The result . . . an increase in production of contact assemblies by 900%.

General Plate clad contact materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate clad electrical contact materials can be put to work for you. Write *now*.



General Plate Clad Contact Materials . . . Single and double inlay, overlay and toplay provide better electrical performance, longer operating life and lower fabrication costs.

METALS & CONTROLS
1009 FOREST STREET ATTLEBORO MASS., U.S.A.
A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

General Plate Products: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

A pretty tough case

An Eastman plastic helped Emerson solve a material selection problem

One of the toughest problems in designing a new product sometimes proves to be choosing the right material.

The Emerson all-transistor pocket radio shown above is a good illustration of how the familiar "process of elimination" often is used in evaluating materials to find one whose properties satisfy all the demands of a specific application.

Here, the need was for a tough housing that would have beauty and light weight, yet be rugged enough to endure hard knocks and outdoor exposure hazards. Important, too, since the radio would be spending a good bit of time in the user's hand, the case had to be made of a material that would be pleasant to the touch.

Only in Tenite Butyrate plastic, did Emerson find a material that met all their needs. Butyrate is an easy-to-mold, lightweight thermoplastic with outstanding resistance to impact and weathering. Its surface is lustrous. Its low heat conductivity assures a warm friendly "feel." And, its availability in both clear and colored forms simplifies assembly and decorating operations. The main case body is molded of colored Butyrate—color that cannot peel or wear off, because it is an integral part of the plastic. The back and one-piece front are molded of crystal-like transparent Butyrate which permits gold-lacquered areas on the inner side to show through.

If you have a product development—or product improvement—problem, look to the Tenite plastics for a possible solution. For more information write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE
BUTYRATE
an Eastman plastic

The Emerson Model 555 "All-American" transistor pocket radio is manufactured by Emerson Radio and Phonograph Corp., 14th and Coles Streets, Jersey City 2, New Jersey. Its case is molded of Tenite Butyrate by Worcester Moulded Plastics Co., 14 Hygeia Street, Worcester 8, Massachusetts.

CIRCLE NO. 47 READER SERVICE CARD

Do you foresee design changes?

...ask Arwood about investment casting

Investment casting offers you just about the most inexpensive, convenient way you can find to get your new part from the drawing board to finished, production line quantities. This is especially true when your design may involve some degree of complexity... a strong, tough alloy... time-consuming machining steps ... expensive tooling.

There are good reasons. With investment casting, tooling is quick and inexpensive. It's easy to modify finished dies as the need for design changes develops. Even more important, Arwood will handle the whole job for you, from blueprints through to the finished part.

It makes no difference what metal or alloy you specify; Arwood casts a complete range of ferrous and non-ferrous materials. The skilled toolmakers at each of our four foundries can turn out fifty or more dies each week. So to save time and cut your costs between the drawing board and finished parts, ready for assembly, get in touch with Arwood.

Write today for your free copy of the new 44-page Arwood "Practical Guide to Investment Casting." It provides all the information you need to evaluate the technique and use it to help solve your design problems.

MACHINE THE SIMPLE...CAST THE COMPLEX

arwood

ARWOOD PRECISION CASTING CORP., 325 W. 44th St., N. Y. 36, N. Y.

A complete service from design through tooling, production and finish machining.
Sixty-two engineering consultants from coast to coast.

PLANTS IN BROOKLYN, N. Y.; TILTON, N. H.; GROTON, CONN. & LOS ANGELES, CALIF.

NEW...

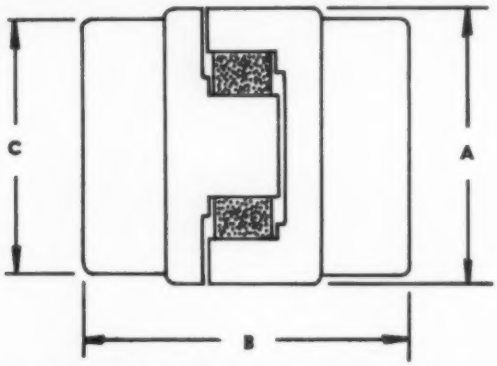
Bonaire

Offer These Advantages:

SPECIFICATIONS and PRICES ON REVERSE SIDE

NEW ALUMINUM

Bondtru® FLEXIBLE INSULATED COUPLINGS



SPECIFICATIONS and LIST PRICES

No.	Max. Bore Inches	Min. Bore Inches	A. Dimen. Inches	B. Dimen. Inches	C. Dimen. Inches	Length thru Ea. Hub Inches	H.P. at 1800 R.P.M.	H.P. at 1200 R.P.M.	H.P. at 600 R.P.M.	Approx. Wgt.	List Price	Separate Insert List Price
BA-13	¾	¼	1 7/16	2 1/16	1 7/16	¾	.40	.280	.17	5 oz.	$1.60	$ .40
BA-316	⅞	⅜	1¾	2 5/16	1 11/16	⅞	1.00	.700	.40	8 oz.	2.15	.50
BA-321	1	½	2 1/16	2 3/16	1 13/16	⅞	2.00	1.400	.80	10 oz.	3.30	.75
BA-323	1⅛	½	2⅜	2⅞	2 1/16	1 1/16	3.25	2.300	1.30	1 lb.	4.50	1.10
BA-325	1¼	⅝	2⅜	3¼	2 5/16	1¼	7.50	5.300	2.70	1½ lb.	6.50	1.50
BA-330	1½	⅝	3 1/16	3 11/16	2 7/16	1⅜	10.00	7.000	3.60	2 lb.	8.00	2.00

Price includes keyways and set-screws (BA-13 has set-screws only). **Allow 20% extra for taper bores.**

The BONDTRU line of Flexible Insulated Couplings is the result of over 60 years research and manufacturing experience. The NEW ALUMINUM BONDTRU COUPLINGS are of the same basic design as the performance-proved standard line of BONDTRU Flexible Insulated Couplings.

Profit by these design and operating features!

LIGHTWEIGHT
Aluminum-light, aluminum-strong.
Weigh up to 60% less than comparable iron couplings.

INSULATED
Nonconducting insert eliminates both static and dynamic electricity—absorbs shock and torsional vibration.

ROUNDED EDGES
All rounded edges promote operator safety.

SELF-ALIGNING
Automatically compensate for end-play, lateral and angular misalignment.

NO LUBRICATION
Eliminates lubrication time and inspection.

ECONOMICAL
Low initial cost.
Low maintenance cost.
Long life.

WRITE TODAY—for more information and your discount!

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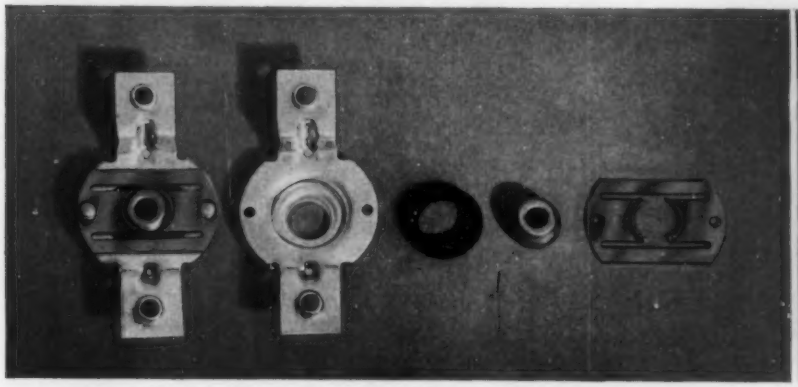
REPRESENTATIVES and DISTRIBUTORS
IN ALL PRINCIPAL CITIES

CHARLES Bond COMPANY
621 Arch Street, Philadelphia 6, Penna.

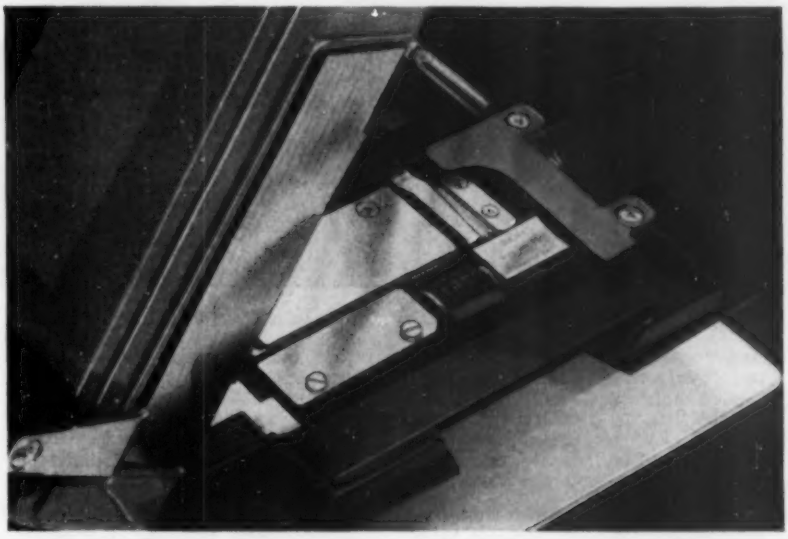
Speed Reducers
Stock Gears
Sprockets
Flexible Couplings

NEW BRONZE CAN CUT SPRING COSTS—

Superfine-grain phosphor bronze by Anaconda now handling many tough jobs, replacing costlier materials.



RETAINING CLIP for a bronze bearing in the Handy Hannah Hair Dryer was originally of spring steel. Rejections ran 20% in the stamping operation and another 20% at the assembly stage. The Handy Hannah Products Corp., Whitman, Mass., switched to Duraflex, Anaconda superfine-grain phosphor bronze, found it had not only the spring quality and fatigue resistance needed for the job—but also had superior formability which eliminated rejections.



SPRING CLIP takes a steady beating as it holds invoices in place in imprinting machines—used widely in handling charge accounts by retail stores and service stations. In the imprinter (right) made by the Farrington Mfg. Co., Needham Heights, Mass., this clip was originally of beryllium copper. Hearing about the superior fatigue life and endurance limit of Duraflex, Farrington consulted Anaconda technical specialists and decided to try it. Duraflex has been doing the job now for two years, stands up in service, saves $1.50 a pound in material cost.

TESTS by an independent laboratory show that design stresses for Duraflex wire and flat springs can be from 33% to 50% higher than for those made from regular phosphor bronze—yet Duraflex costs no more than regular phosphor bronze. Get the test reports and revaluate all your components requiring spring properties. For copies of these reports or technical help in selecting the right alloy and temper, see your Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5045

DURAFLEX®

SUPERFINE-GRAIN PHOSPHOR BRONZE

A PRODUCT OF

ANACONDA®

Made by The American Brass Company

NOW! FABRICATE COMPLEX CASTINGS WITH 3M ADHESIVES!

Here's a new, virtually fool-proof way to fabricate complicated hollow castings. Simply bond and unitize individual *die*-cast *sections* with high-strength 3M structural adhesives, such as EC-1386. You'll cut rejects and costs, boost production, too.

Die-casting of sections eliminates rejections due to blow holes in sand core castings . . . means smoother, more detailed parts because of the machined surface of the metal die. And by bonding with 3M Adhesives rather than mechanically fastening sections, there's no need for costly machining and equipment, no wasteful bosses or flanges to eat up space. Easily applied with a flow gun, EC-1386 is 100% nonvolatile, and requires no pre-drying before joining sections.

With EC-1386, indexing or pressure jigs are not needed. The adhesive cures to high ultimate strength quickly in an air-circulating oven. (At 500°F, curing time is only one to two minutes.) And the cured bond can be machined for final touch-up operations.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU!

3M structural adhesives are doing many things in many fields. For more information and literature on the complete line, contact your 3M Field Engineer or write direct: A. C. & S. Division, 3M, Dept. SAS-99, St. Paul 6, Minnesota.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

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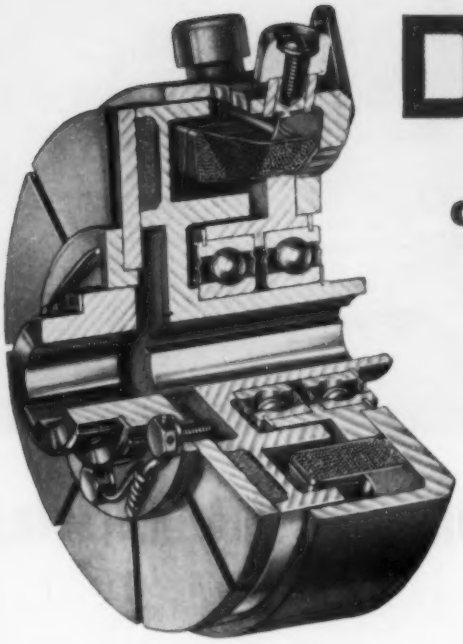
Small Units for Big Jobs!

EATON DYNA-TORQ

MAGNETIC-FRICTION CLUTCHES and BRAKES



STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

Now Available in a Full Line from 1¾" to 15" Diameter

Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The smaller sizes and advanced design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.

Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities

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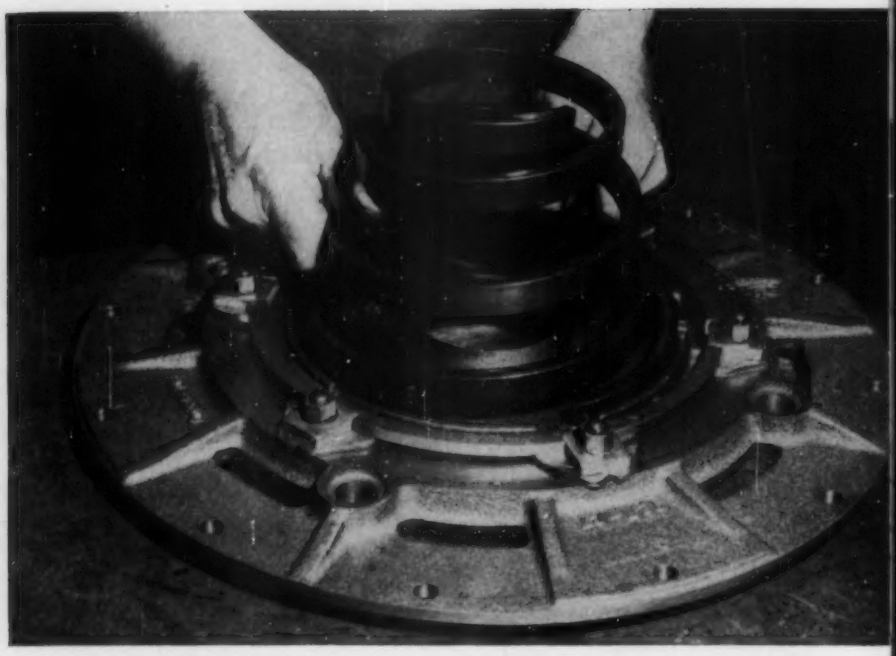
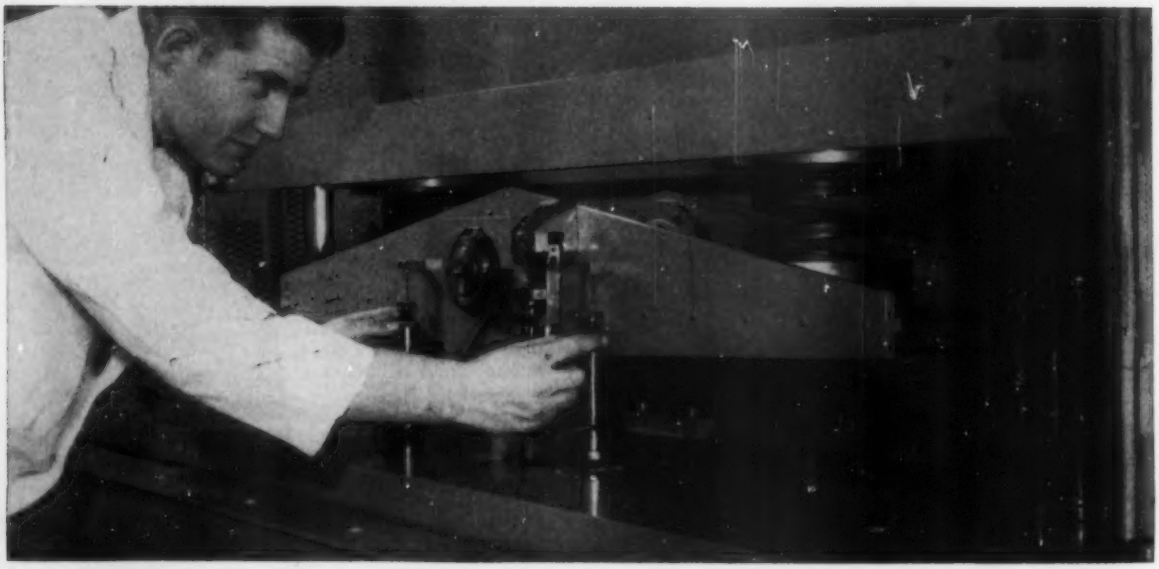
CIRCLE NO. 53 READER SERVICE CARD 53

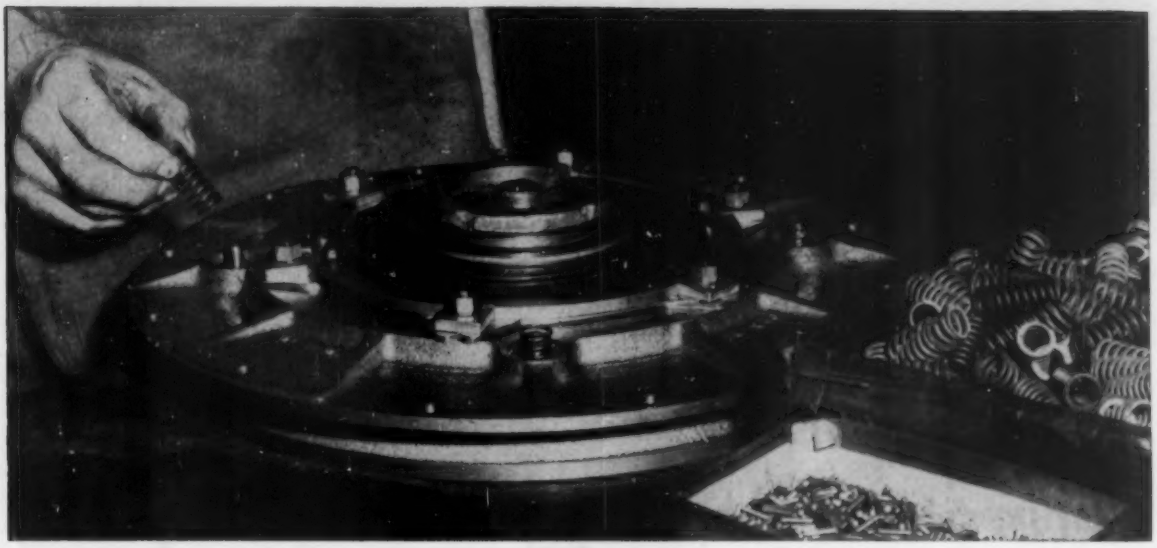


USS American Springs give longer life,



In the AS&W Spring Laboratory a semi-resonant spring fatigue machine is testing the Lipe-Rollway clutch spring. At speeds of 700 cpm this spring is functioned beyond its normal life span and at higher than normal stresses to prove conclusively its superior design as a clutch spring.

A USS American flat wire compression spring is shown in place in the Lipe-Rollway clutch. Four round wire compression springs are also being installed in the clutch.



better performance in heavy-duty clutches

...thanks to AS&W Spring Engineering Research Service

The Lipe-Rollway Clutch Division, Lipe-Rollway Corporation, Syracuse, N. Y., manufactures automotive clutches for heavy-duty trucks, tractors, buses and other large mobile equipment. Because USS American Springs play a vital part in the performance of these clutches, Lipe-Rollway asked the AS&W Spring Engineering Research Service to test the springs and determine if any changes should be made in the design to improve and maintain the high performance standards.

As a result of these tests the AS&W Engineers recommended certain important changes to give the springs longer life. After this recommendation was adopted by Lipe-Rollway, Mr. Harvey Gray, Chief Inspector & Quality Control, had this to say: "Exceptional service has been realized from our American Steel & Wire Springs."

If you have a spring problem or would like advice on the use of springs in your product, get in touch with our general office in Cleveland, or any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels—from steel chemistry through product application—to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal.

American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS and American are registered trademarks

American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

CIRCLE NO. 55 READER SERVICE CARD

NAUGATUCK

ANNOUNCING...

...tough new thermoplastic rivals the properties of nylon, costs less than half as much!

New KRALASTIC® MM, newest of the world's leading family of ABS resins, offers such a combination of toughness... resistance to heat, staining, and abrasion... and other high chemical and physical properties that it actually compares directly with nylon. Yet with all its nylon-like properties, new KRALASTIC MM in its resin form costs only about 40% as much. *And when molded, new MM costs far less.*

KRALASTIC MM molds well, requires no special techniques, nor post-mold conditioning. With its low moisture absorption, mold design is simplified.

Rigidity and creep resistance of KRALASTIC MM are exceptional for a thermoplastic with high modulus. *New MM retains its modulus better than any other impact plastic.*

Though KRALASTIC MM resists most organic solvents, it may be readily painted or printed with standard techniques and equipment. And with all of its outstanding chemical resistance, MM's susceptibility to a few specific solvents permits the welding of separately formed pieces into one homogeneous product—adding still further to its unique combination of product superiority and production economy.

KRALASTIC MM

KRALASTIC MM—Comparative Properties

(Columns 1 and 2 are as molded; column 3 shows influence of moisture pickup on nylon. For average air exposure, 73°F, use Cols. 1 and 3. Blank entries in Col. 3 denote no information available on change due to moisture pickup.)

	Costs and Properties	Kralastic MM (ABS-blend)	Nylon 6/6	
		1	2	3
	Moisture content, %...	0.35	0.2	2.5
GENERAL	Specific gravity	1.07	1.14	
	Cost, cents/cu. in.	2.0	4.9	
	dollars/lb.-volume	0.54	1.35	
	Molding cost			
	tooling (includes proto. work)	Normal	High	
	production rate	Normal	Normal	
	Ease of molding	Good	Fair	
	Mold shrinkage, mil/in.	4	15	
	Moisture absorption (24 hr.), %	0.3	1.5	
	Abrasion resistance (Tabor CS17 wheel, mg/1000 cycles)	14–15	6–8	
MECHANICAL	Yield strength, psi × 10^3	8.8	11.8	8.5
	Flexure modulus, psi × 10^3	450	430	175
	Elongation, %	20	60	300
	Flexural strength, psi × 10^3	13.5	13.8	—
	Impact strength (notched Izod), ft.-lb./in.	1.5	0.7	2.0
	Rockwell hardness, R scale	118	118	108
	M scale	66	79	59
THERMAL	Heat-distortion temp.			
	(264 psi), °F	200	350	
	(66 psi), °F	217	500	
	Heat resistance (continuous), °F	180	250	
	Expansion coeff., in./in./°F × 10^{-5}	3.2	5.5	
	Conductivity, btu/hr./sq. ft./°F per in.	1.80	1.68	
	Flammability	Slow-burning	Self-extinguishing	
ELEC-TRICAL	Dielectric strength, volt/mil	386	385	
	Volume resistivity, ohm/cm × 10^{14}	270	0.5	
	Dielectric constant	3.1	3.9	

Investigate the material advantages new KRALASTIC MM offers

Contact your Naugatuck Representative or send the coupon for more complete information. Free samples of New KRALASTIC MM are available for challenging applications.

Naugatuck Chemical Division
United States Rubber Company
930K Elm Street, Naugatuck, Connecticut

☐ Please send further information on KRALASTIC MM
☐ I am interested in KRALASTIC MM for_____

APPLICATION

NAME

TITLE

COMPANY

STREET

CITY ZONE STATE

United States Rubber
Naugatuck Chemical Division NAUGATUCK, CONNECTICUT

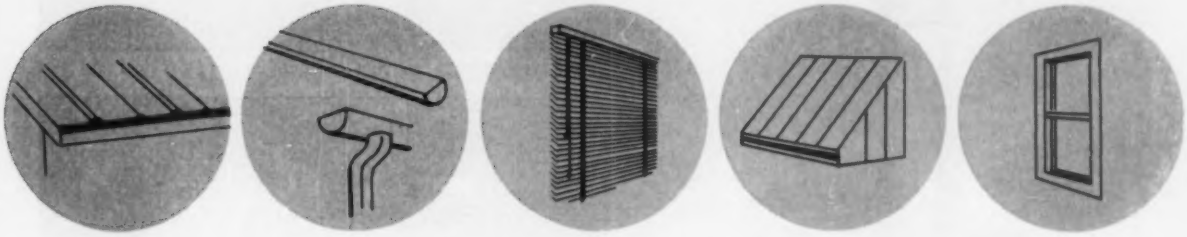
KRALASTIC RUBBER-RESINS • **MARVINOL** VINYLS • **VIBRIN** POLYESTERS

Akron · Boston · Gastonia · Chicago · Los Angeles · Memphis · New York · Phila. · CANADA: Naugatuck Chemicals · Elmira, Ont. · Cable: Rubexport, N.Y.

Photo courtesy LITHO-STRIP CORPORATION, Chicago, Ill.

BONDERIZED ALUMINUM

makes your painted products look better longer



Most famous of all surface treatments for metals—BONDERITE—makes painted aluminum look better longer.

Bonderite on aluminum means fine appearance longer, because it controls corrosion and anchors the paint.

Bonderized and painted aluminum is produced on automated strip lines in which the metal is cleaned, Bonderized and painted, then re-coiled ready for use.

Stamped or roll-formed products are made from pre-painted, Bonderized aluminum coil without loss of paint adhesion, even from the most severe deformation. Here's production efficiency and economy at its best—better products at less cost.

Many Applications of Bonderite for Aluminum

There's more than one type of Bonderite for use on aluminum. In wide use is Bonderite as a base for paint, which adds durability and long life to paint finishes on so many aluminum products.

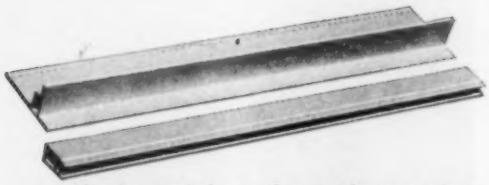
Another Bonderite produces an attractive green coating, used on many architectural products without further finish.

Protection without changing the characteristic color of the metal is provided by another Bonderite.

There is also a Bonderite, formulated for mixed production, which coats aluminum, steel and zinc.

Bonderite for aluminum meets and exceeds the requirements of Government Specification MIL-C-5541.

Well over two hundred plants—large, medium-sized and small—use these great Parker products on their aluminum production. Better investigate for *your* plant, today!



Aluminum window and screen frame sections Bonderized, painted and formed after painting. No breaks in finish anywhere! (Courtesy, Security Co., Detroit, Mich.)

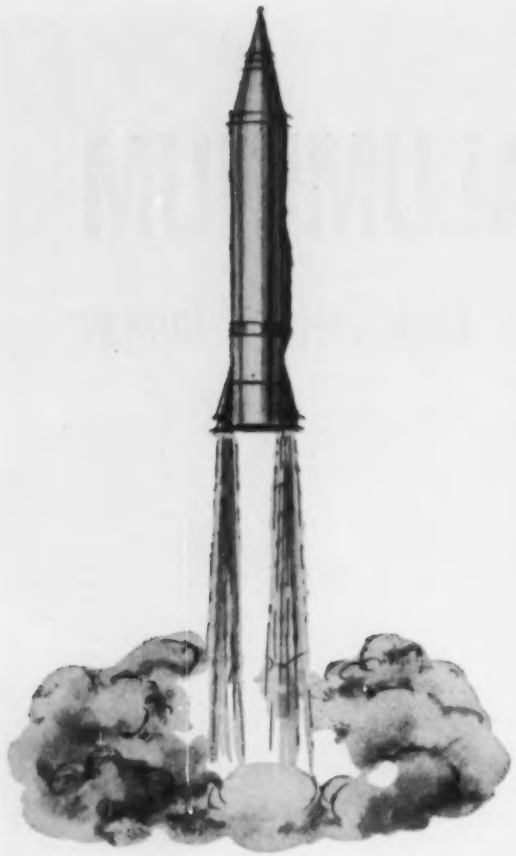
SEND FOR ILLUSTRATED BULLETIN!—*Free bulletin, with more complete information and details, mailed immediately upon request. Ask for Bulletin A6790, "Bonderite for Aluminum."*

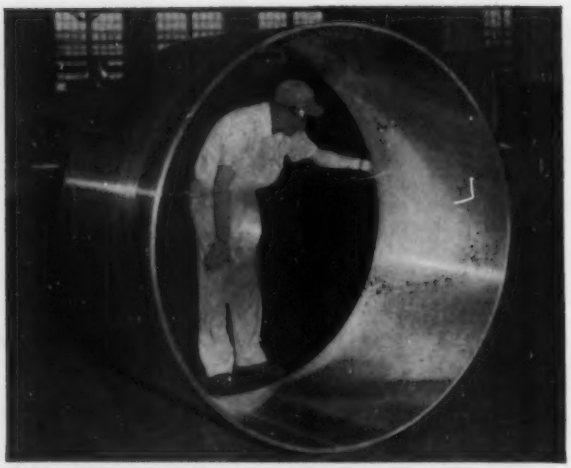
Parker Rust Proof Company

2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE corrosion resistant paint base	BONDERITE and BONDERLUBE aids in cold forming of metals	PARCO COMPOUND rust resistant	PARCO LUBRITE—wear resistant for friction surfaces	TROPICAL—heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*





First stage motor case ring—vacuum-melted D6A steel

Second stage motor case ring—vacuum-melted 300M steel

Third stage motor case ring—air-melted AMS-256 steel

QUALITY OF "MINUTEMAN" MISSILES PARTS DETERMINED BY STANDARD STEEL WORKS RESEARCH

Months of research and development of various rigid quality-control procedures at Standard Steel Works Metallurgical Laboratories preceded the delivery of "Minuteman" missiles parts of extremely high-quality material.

Standard Steel Works' laboratory facilities—second to none in industry—make possible delivery of unusual forgings from special steel alloys in record time. Missiles parts of the highest cleanliness ratings have been furnished from both air and vacuum melted steel. All are subjected to ultrasonic inspection under water for defects and to microscopic examination for cleanliness.

Standard Steel Works Division
BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

LINK-BELT GEARMOTORS . . .

cool-running!
quiet!
compact!

Where inches count . . .
LINK-BELT Gearmotors
make the most of mounting space

If you're after (1) high-efficiency speed reduction (2) performed in close quarters—look no longer. You get the best of both with Link-Belt Gearmotors.

- COOL-RUNNING—due to precision-cut, hardened gear trains that minimize friction.
- QUIET—a result of smooth-meshing gears and cast-iron, one-piece housing.
- COMPACT—because of simple gear trains and flange-connected motor that requires no additional coupling devices.

Available in double, triple and quadruple reductions—ratios from 6.2:1 to 985:1 . . . up to 100 hp.

FOR FULL-LINE FACTS

on Link-Belt's comprehensive line of speed reducers—contact your nearest Link-Belt office . . . or check and send this coupon to Link-Belt Company for data on all or any combination of the following:

- [x] gearmotors—Catalog 2747
- [ ] motogears—Catalog 2747
- [ ] helical gear speed reducers—Catalog 2751
- [ ] shaft-mounted speed reducers—Catalog 2618
- [ ] worm gear speed reducers—Catalog 2324-A
- [ ] universal worm gear speed reducers—Catalog 2724
- [ ] parallel shaft speed reducers—Catalog 2619
- [ ] fluid drives—Catalog 2747
- [ ] P.I.V. speed changers—Catalog 2274

LINK-BELT

15,284

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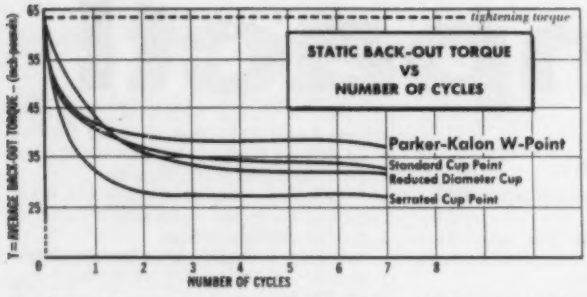
Another new fastener idea from Parker-Kalon

30% more back-out torque
50% more resistance to vibration
50% more resistance to rotary slippage
with the New P-K® W-POINT SOCKET SET SCREW

NOW YOU CAN OBTAIN THE HIGHEST DEGREE OF HOLDING POWER EVER ATTAINED

30% MORE BACK-OUT TORQUE

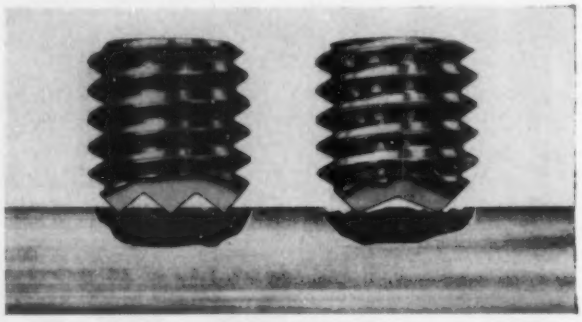
In a series of tests, performance of the new P-K *W-Point* was matched against that of small cup, serrated cup and standard A.S.A. cup point screws. A number of blocks and shafts were matched to precision tolerances for each of



the four set screws under observation. Again and again each screw was tightened on a new portion of the shaft, the screws loosened and the back-out torque recorded. Results were consistent and conclusive. In every test there was less decay in back-out torque for the new *W-Point* than for any of the other three types.

50% MORE RESISTANCE TO VIBRATION

In all tests under normal conditions of vibration, the other three types of set screws loosened and rapidly lost their holding power. Examination to determine the cause showed that with all other screws, final tightening caused them to deviate from the axial line through the center of the screw which in turn caused uneven tracking. The tests indicated that unless the cup point forms a true track in the shaft, vibration will result in loosening within a very short period of time. At the conclusion of each test run, the new P-K *W-Point* was still seated securely and in tight frictional contact with the shaft.



50% MORE RESISTANCE TO ROTARY SLIPPAGE

W-Point set screws, small cup, serrated cup and standard A.S.A. cup point screws were test-matched on various types and sizes of shafts at rest, in motion, and in start-and-stop operation. Examination of the impressions left on the work showed that all other types of cup point set screws when tightened, created tracks which are uneven in depth and shape. Impressions made by the new *W-Point* were perfectly circular and even in depth at all points on the circumference. There was also clear evidence of rotary slippage by the other cup point screws while the sharp pivot point of the *W-Point* Set Screw effectively prevented such slippage.

WOBBLE AND TIPPING CONTROL

Users of cup point set screws have long recognized two problems directly related to the proper seating of the screw on the work . . . "*wobble*" and "*tipping*". Until now, "wobble" could not be avoided because of the tolerance clearance which must be provided between screw threads and the tapped hole. In addition, users of conventional cup point set screws are aware of the fact that the key itself imparts a tipping movement to the screw during the tightening operation. The result of these two factors often results in a weakening of holding power. Upon completion of the torquing of a conventional cup point set screw, only a part of the flank of the cup edge remains in frictional contact with the work. The guidance provided by the carefully engineered construction of the new P-K W-Point, reduces "wobble" and "tipping" to an absolute minimum—results in true circular tracking by the cup edge with flanks in intimate frictional contact with the work. With "wobble" and "tipping" eliminated, the *increased contact areas* PLUS the *new pivot point* PLUS Parker-Kalon's uniformly finished Class 3A "*ground thread*" quality feature, provides the revolutionary W-Point with an inherent resistance to loosening . . . *a frictional grip superior to any type of cup point socket set screw now in use!*

TEST THE NEW W-POINT FOR YOURSELF

You are cordially invited to examine and test the new P-K W-Point socket set screw in your own plant. When you do, notice its precision manufacture, its perfectly finished ground threads, the well-defined last full thread. Like many important advances in technology, the W-Point concept is simple and straightforward. In use, its superior performance and holding power will be demonstrated to your own satisfaction.

NO INCREASE IN COST

You get all the advantages of this revolutionary improvement in socket set screws *at no increase in price!* The W-Point is available in #4 to 1" diameters in Alloy, and #4 to ½" diameters in Stainless Steel . . . stocked in popular sizes. Other sizes made to order. Approved, Military Standards, 51017 through 51024.

FOR SAMPLES AND COMPLETE TECHNICAL DATA, CALL YOUR P-K INDUSTRIAL DISTRIBUTOR, OR WRITE DIRECT TO P-K FOR BULLETIN NO. 1106

Look to Parker-Kalon for quality Socket Set Screws, Cap Screws, Shoulder Screws, Button Head and Flat Head Socket Screws, Pipe Plugs and Dowel Pins . . . the most complete line in the industry. PARKER-KALON, a division of General American Transportation Corporation, Clifton, New Jersey. Offices and warehouses in Chicago and Los Angeles.

PARKER-KALON

W-Point Socket Set Screws*

*Patent Pending

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In seconds, you can front-mount trim, name plates, grilles, knobs, insulation, with Tubular SPEED CLIPS. And at interesting savings in assembly time and costs!

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TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

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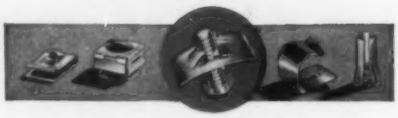

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CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

Product Engineering

HORIZONS

September 14, 1959

THEORIES ARE NETS . . .

. . . only he who casts will catch." So wrote Novalis (pseudonym for Von Hardenburg), a German poet who died in 1801. Yet the theorist is laughed at by the static mind, because he dares to suggest something different. Antimatter and antigravity were five years ago the postulations of men a bit off their rockers: now there's experimental evidence to support them. Ten years ago, fifteen years ago, there were theories that are now such accepted laws that no one debates them.

Trace any idea back through the years and you find the scoffers, the majority that knows better because what it sees or reads is so. The majority fights theories, because they're disturbing–they tend to upset the apple cart. Go back only a little way and the exception to the rule was promptly labeled a miracle–and miracles of course don't repeat.

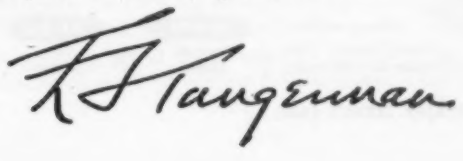
This saved trying to think through the occurrence or listening to the theories of the miracle maker. It happened–period. If he persisted in propounding a theory about it, and experimented to repeat the miracle, he was shut away, tortured or killed ingeniously as anything from a practicer of black magic to a warlock. So miracles were few and far between–it wasn't a healthy business unless you could produce thunder and lightning on demand, or get a powerful sponsor.

Then education became common, and the old miracles were explained. Even alchemy became a respectable ancestor to chemistry, much as a society family glamorizes and humanizes the memory of the old pirate who established the line.

In recent years, miracles have become so common that nobody recognizes them anymore. We move promptly from miracle to theory to law. There are still scoffers, but they're competing miracle makers–*hoi polloi* either accepts the miracle or quietly tiptoes away shrugging its collective shoulders.

This creates an interesting situation, in which the charlatan can propound a theory just as readily as the honest researcher. Again Novalis' statement applies, for "he who casts will catch"–suckers. And the bigger the theory net, the bigger the catch. The individual buys a uranium or electronic stock because rockets must include such components. And the nation buys any proposal that might show our one-upmanship over the Soviet Union.

We should remember that the net represents a considerable advantage only to the caster. It's a real menace to the fish. And nets have caught men–physically in the sea and in the Circus Maximus, mentally whenever we nod, either because of sleepiness or too-ready agreement.



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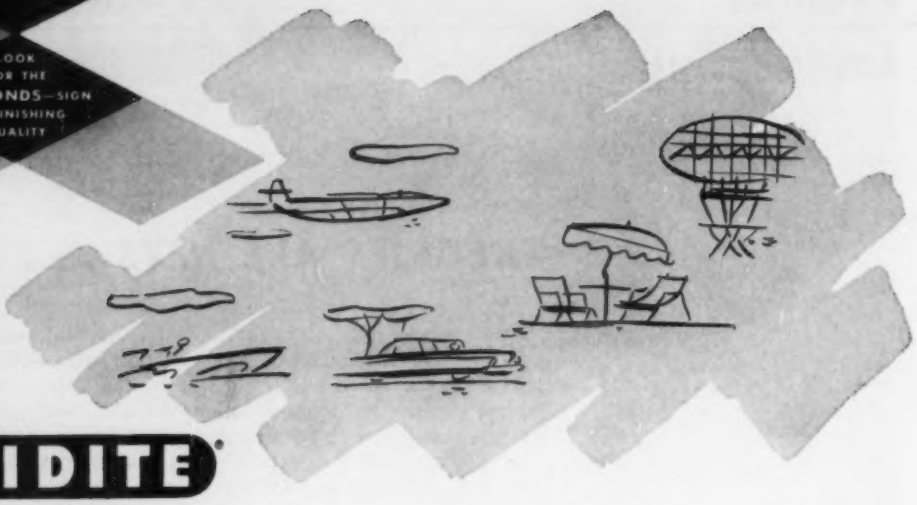

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Courtesy: Worthington Corp.

Colored pipes and machines . . . *in Idlewild International Airport's new heating and air-conditioning building demonstrate that functional color can be eye-catching as well. Through the huge show-case windows you see red hot-water pipes, green circulating-water pipes, blue cold-water pipes, and orange-colored motors and electrical conduits. White machines at right end of building are absorption-cycle refrigeration machines totaling over 600 tons capacity — largest such installation in the world.*

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WHEN EQUIPMENT SAYS IT IN COLOR

Here's a coding system that efficiently conveys information from the machine to its operator. What do the different colors say? How can design use the eye-catching language?

J L SEMINARA
Human-factors specialist, Dover, NJ

A red light stops you quicker than a sign that spells out STOP.

It's the color that does it — certain colors can cause a conditioned response faster and more efficiently than any other type of presentation. This principle can be put to work usefully when designing but it calls for knowledge of color standards and the mechanism of color vision.

Color can be used three ways: to increase the attention-getting power of an item or component; to impart a specific piece of information to a machine operator or maintenance man; to standardize association between a given color and a certain function. In each case the purpose is functional — to convey information quickly and increase the efficiency of the man-machine combination.

Two peculiarities of vision . . .

must be appreciated if color is to convey information effectively. First: the colors that appear brightest under normal illumination do not appear brightest under reduced illumination. Second: 10% of the male population is color-blind to some extent — this calls for picking

those colors that will be the least confusing to the majority of color-blind operators.

Shift in apparent brightness can be best understood by imagining a string of colored lights radiating equal amounts of energy and representing all the colors of the spectrum. When seen at night from a short distance, all lights will seem bright but the yellow-greens will seem brightest. As the observer moves away from the lights they become more faint and lights that appear brightest begin to shift away from yellow-greens toward lights of shorter wavelength. With increasing distance, all lights are seen as greys of various intensities – the light from the reds and oranges fading out first, the greens and yellows next, and the blue-greens last.

When choosing signal lights which must be seen at night, blue-green lights (seen as greys) will be most visible. But yellow-green lights – if they can be seen at all – will show the most color. Therefore, if signal lights must be identified by color, choose high-intensity yellow-green first; then oranges and reds of higher intensity; and finally, blue-greens, blues and violets of even higher intensity. Another general rule: the greater the number of lights that must be identified by color, the brighter should be the light for each color.

On the other hand, when lights should not be visible to a distant observer at night (illuminating military equipment, for example) specify yellow-orange or red lights.

For a sharp change in illumination level the eye requires 30 to 45 min. for full adaptation. But an operator who wears red goggles in bright light will not be blinded when he walks into a dimly lit control room–the red lenses filter out the bright colors that slow down adaptation to the dark. In a darkened room, instruments should have red backlighting. Brighter colors (blue-green for example) work against adaptation and make unlighted controls very difficult to see. Radar consoles often use red light for oscilloscope traces and instrument backlighting.

Color blindness varies all the way from inability to see any color at all to simply a small difficulty in discriminating between certain colors. Most "color-blind" persons are baffled by reds and greens. But even with this marked deficiency such persons are hard to spot because they learn to label grass as green even though it looks blue. However, tests consisting of geometric figures hidden in a pattern of various colored dots will usually put the finger on a person with such deficiencies.

Color coding simplifies . . .

the matching of related components. If, for example, a number of cable plugs are to be connected

what CO OR does to your eye

The colors we see depend upon the wavelengths falling on the eye; normal eyes respond to the range between 4000 and 8000 angstroms.

The eye's retina contains two kinds of sensory cells, rods and cones. The cones located in the central portion of the retina transmit color information to the brain. Color blindness generally involves some deficiency of these cones. Rods predominate in the peripheral portions of the retina. Though not sensitive to color (they see everything in terms of blacks, whites and grays) rods are more sensitive than cones to all wavelengths of light.

Dim light

Perception of light in daylight conditions is shared between rods and cones. As intensity of illumination decreases, colors not only "gray out" (as cones become less and less active), but there is also a shift in the response characteristics of the eye. Colors appearing brightest under normal illumination are not the same as those that look brightest in dimmer lighting. This "Purkinje effect" is attributed to different responses by the cones and rods. Cones are most sensitive to the yellow-green band so these colors will seem brightest in normal daylight. Rods (which do not recognize color) are most sensitive to blue-greens; light of this wavelength will seem brightest under low illumination.

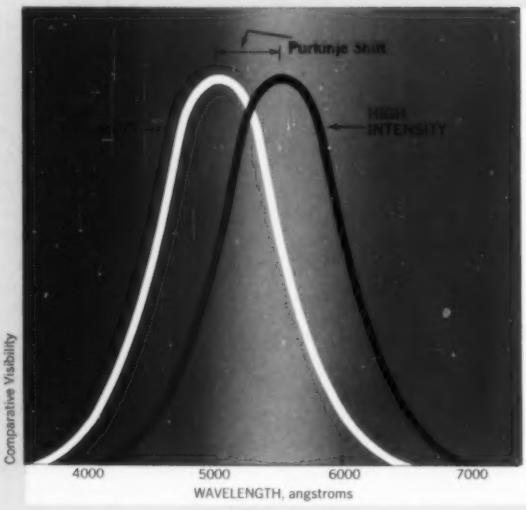
Defective color vision

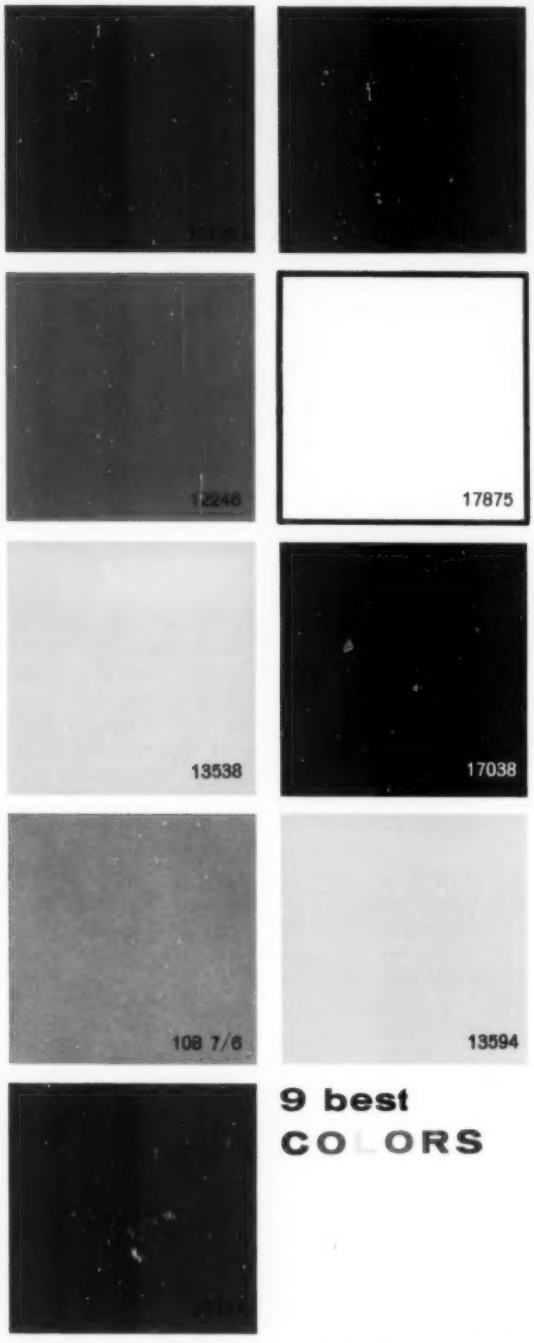
Color blindness comes in three levels of severity. One is true color blindness (monochromatism) where all vision is in terms of blacks, whites, grays – but this is very rare.

Color-blind persons are more commonly red-green blind (dichromatic): the shorter waevlengths (greens) appear blue; longer wavelengths (reds) are seen as yellow, and an in-between band appears colorless.

Most common deficiency is found in the person who simply has a slight inability to distinguish between certain colors (anomalous trichromatism).

Purkinje shift . . .
occurs as light intensity decreases. Blue-green band appears brightest at low levels; yellow-green band at high levels.





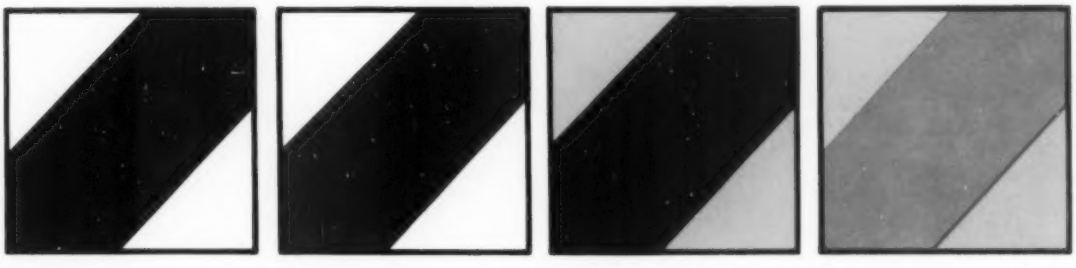
9 best COLORS

to specified receptacles, colors that unmistakably pair the correct plug-receptacle combinations are cheaper than fancy harnesses; quicker and more attractive than plugs of different geometry. Similarly, color-coded test points on maintenance equipment, and brightly colored pipes or circuits will distinguish items that otherwise look pretty much the same.

Colors for color-coding must be carefully chosen. Color-blind operators will occasionally confuse colors that are vastly different; even normal vision is not sufficient to discern subtle color differences. Normal vision can distinguish 100,000 to 300,000 different colors when they are compared two at a time and side by side. But working conditions (with color-coded electrical components, for example) do not allow such comparisons. The average individual can differentiate only about 10 colors with precision. These 10 (with wavelengths expressed in angstroms) are usually: violet (4300), blue (4760), green (4940, 5040, 5150), yellow (5360, 5820,) red (5960, 6100, 6420).

When there is a chance that equipment will be operated by persons with a color deficiency, only nine colors are recommended (see color chart at left). These basic colors can be made to give more than nine coding elements by combining two colors in patterns. If signal lights are coded in situations

The advantage . . . *of the informational colors shown at left is that they are least likely to cause confusion — even for persons with a color deficiency. Stripes below exemplify suggested two-color patterns if more than nine coding elements are needed. Code numbers refer to Federal Specification FS-595, with exception of Blue 10B 7/6 which is from* Book of Color, *Munsell Color Book Co, Baltimore, Md.*



COLORS tell it in code

For safety around industrial equipment, color has been given this language in codes of the American Standards Association and National Safety Council.

COLOR (and Code No.*)	ITS MEANING
11105	**Fire protection.** Equipment such as alarm boxes, extinguishers, etc. **Danger.** Obstruction or cans with flammable contents. Also danger signs. **Stop.** Emergency switches that stop equipment.
12246	**Moving parts** of machinery that can injure operators; cutting edges, flywheels, belt-driven wheels.
13655	**Caution.** Hazards that may cause stumbling, falling, collision, etc. Patterns of yellow and black can be used to designate mobile equipment, unguarded platforms, pillars and columns, and caution-signs in general.
14260	**Safety.** First-aid equipment, first-aid kits, stretchers, gas masks, etc.
	Caution. Warning against starting or movement of equipment under repair; signs for elevators, ovens. **Protective materials.** National Safety Council suggests this color band for antidotes for poisonous fumes; emergency showers.
12197	**Radiation Hazards.** Used with yellow for tags, labels and signs. For designating rooms, containers, and general areas in which radioactive materials are stored or where there is contamination. **Valuable materials.** National Safety Council recommends this color band for scarce or expensive materials that should not be wasted.

*Code numbers refer to Federal Specification FS-595 available from Business Service Center, Region 3, 7th and D Streets SW, Washington 25, D. C. Same source has individual 3 x 5-in. color samples at 5 cents each. Paint manufacturers are familiar with the Specification and can supply paint specified by number (usually from stock).

where a miscue by color-defective operations would be critical, three colors are suggested – Aviation Red, Aviation Blue, Aviation Green (Military Specification MIL – C-25050: "Colors, Aeronautical Lights, and Lighting Equipment"). Manufacturers of colored lenses and lighting equipment can supply lights complying with chromaticity requirements of this specification.

Standard color codes . . .

have been established by both the American Standards Association and National Safety Council for marking in-plant machinery and equipment to alert personnel to hazards, moving parts and fire-protection equipment. The Interstate Commerce Commission requires that shipping lables be color-coded too. Black letters go on a green background for compressed gases; a red background for flammable liquids and fireworks; a yellow background for flammable solids and oxidizing materials; white background for acids.

An elaborate coding system is used for marking values of electrical components, such as resistors, capacitors, fuses. Transformer leads are often coded this way too. And it is recommended that the wiring in an electronic chassis match standard practice: red for plate-supply voltages, black for ground, brown for filament voltages, etc. Other specific codes cover pyrotechnical supplies and various forms of ammunition.

Attention-getting colors against contrasting backgrounds can be used in conjunction with the codes to play up important or potentially dangerous areas. For example, in testing visibility of road signs, it was found that yellow was most visible against black; green against white; and blue against orange.

In the plant, stationary parts of machinery should be painted a neutral gray, and moving parts given a contrasting light buff. Fork trucks, loaders and other mobile equipment will be easy to spot if they are bright yellow with bumper striped yellow and black.

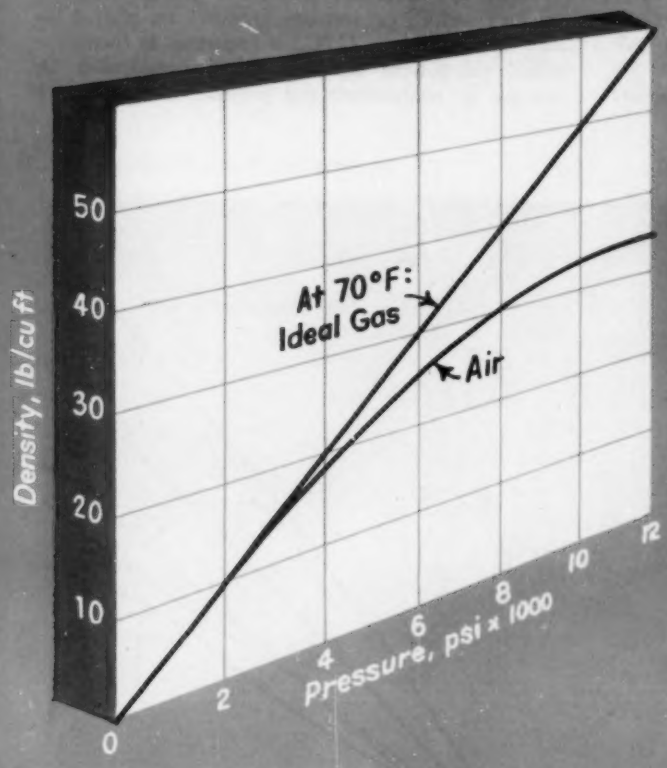
EDITOR'S NOTE: It is often necessary to specify with a precise notation the desired color and degree of surface reflectivity. "The Measurement of Color and Gloss," Feb '56, p 176, describes a number of standard tests and test instruments helpful in specifying or measuring colored-surface finish.

Besides their purely functional aspects, colors are often chosen to match product function, to create sales and advertising appeal, for safety and maintenance considerations. See "How to Plan Product Colors," Aug '51, p 139.

For a detailed analysis (in full color) of unusual and attractive colored coatings for metal, see "Textured Organic Coatings," Apr '51, p 129; "Colored Finishes for Copper," Dec '56, p 135; "Color and Textures for Aluminum," Sep 30, '57, p 101; "Pre-painted Steel," Dec 9, '57, p 99; "Textured Steel," Mar 17, '58 p 73; "New Look in Porcelain Enamels," Nov 24, '58, p 53.

new data for...

HIGH-PRESSURE AIR



Tests by Amsterdam Institute have extended the range of air properties far above the 100 atmospheres covered by the Bureau of Standards. Although there is still disagreement on many high-pressure properties among various groups, the author has correlated diverse data to give these useful curves from 0— 12,000 psi and —150 to 250 F.

T H CHADWICK, *engineering staff specialist*
P L BRADY, *pneumatics group engineer*
Convair, div of General Dynamics Corp
San Diego, Calif

It is predicted that air at relatively high pressures—to 6000 psi and even higher—will be commonplace in design in several years. The reason? Air is plentiful, fast acting, non-toxic and it doesn't burn up or wear out when the going gets tough. And with high pressures plenty of power can be packed into little space.

However, a major obstacle in the development of high pressure air as a power medium is lack of consistent data on its properties—therefore its behavior in systems—at pressures over 1500 psi.

Part of the answer is found in the accompanying curves. They are based on a selective compilation of test data from all known sources. Most of the useful information for pressures above 1500 psi, however, was from Amsterdam Institute in Holland.

Values given in all curves are reasonably accurate, with these limitations:

- Velocity-of-sound data above 2000 psi was obtained partly by extrapolation.
- Sources disagree concerning effect of pressure on viscosity, particularly at the higher temperatures and pressures.

(CONTINUED ON NEXT PAGE)

REPRINTED circle p4, inside back cover

Compressibility Factor

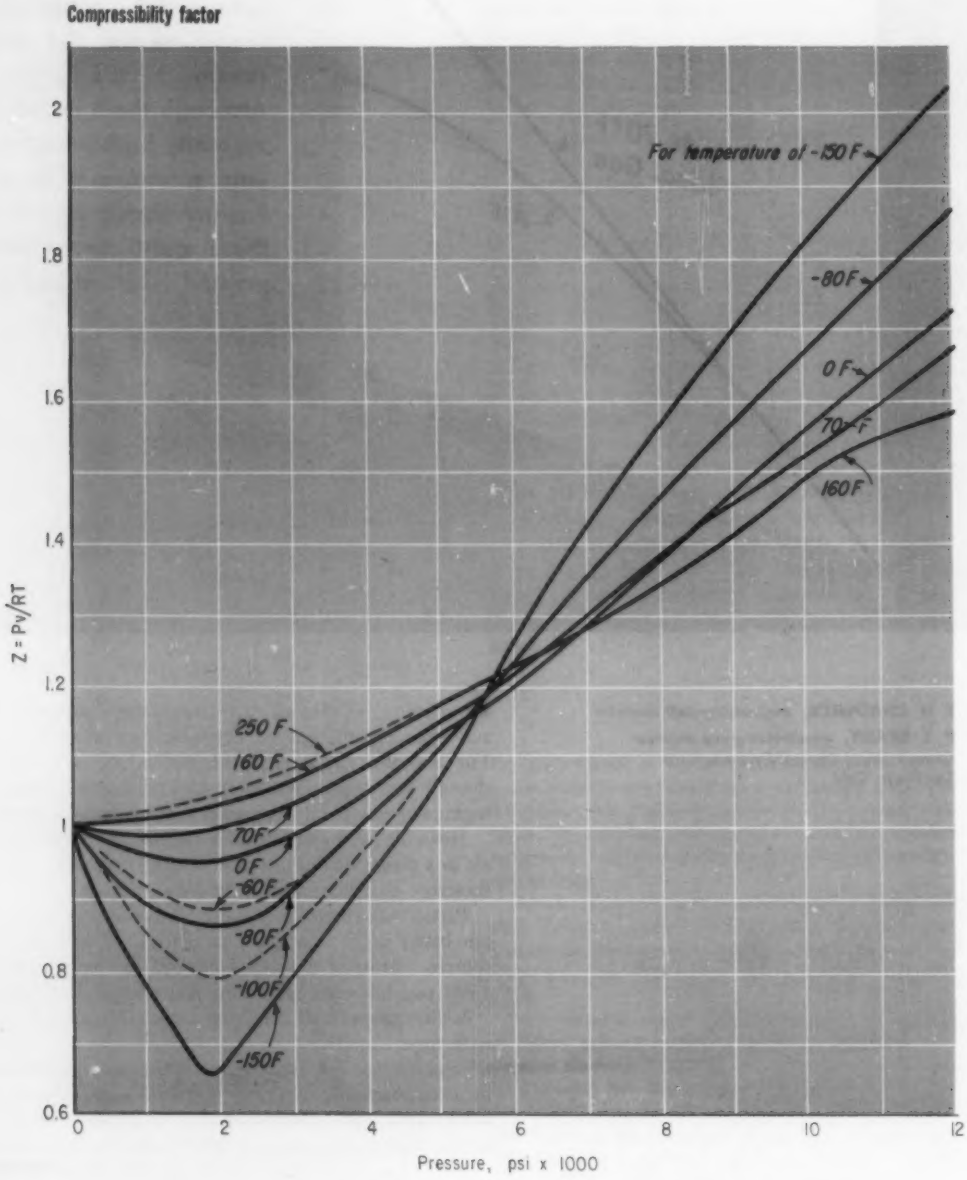
A compressibility correction factor, Z, inserted in the ideal equation of state, $Pv = RT$, will make the equation valid for a real gas. Thus, $Pv = ZRT$, where P is pressure in lb/sq ft, v is specific volume in cu ft/lb, R is a perfect-gas constant (53.3 for air), and T is temperature in deg Rankine (absolute).

Factor Z, plotted on this page for real air, depends on temperature, pressure and the nature of the gas. If the value is known for each condition, then perfect gas relations apply. At points where Z is unity, a real gas behaves as a perfect gas.

A way to express the deviation of air from the perfect state is as a percentage of ideal compressibility: $100(Z - 1)/1$. The next plot, obtained from separate source data than those for factor Z, gives this deviation in the range from 0-5000 psia, −100 to +250 F. A positive value indicates greater specific volume than that for a perfect gas at the same temperature and pressure.

Specific-Heat Coefficients

Individual values for coefficients C_v (at constant volume) and C_p (at constant pressure) are plotted below. The ratio, $k = C_v/C_p$, is important to thermodynamic calculations and is affected considerably by changes in temperature and pressure. In general, k



increases directly with pressure, but inversely with temperature.

Velocity of Sound

For a perfect gas, the velocity of sound $a_s = \sqrt{kgRT}$, where g is 32.2 ft/sec²; other units are already defined. For air, velocity of sound is 1126 ft/sec at 68 *F*, 14.7 psia. For low pressures (less than 100 psia) this velocity is relatively independent of pressure (changes in density are compensated by changes in elasticity) and is roughly proportional to the square root of temperature. In round figures $a_s = 49\sqrt{T}$. Example: At 70 *F*, 14.7 psia, $a_s = 49\sqrt{530} = 1128$ ft/sec.

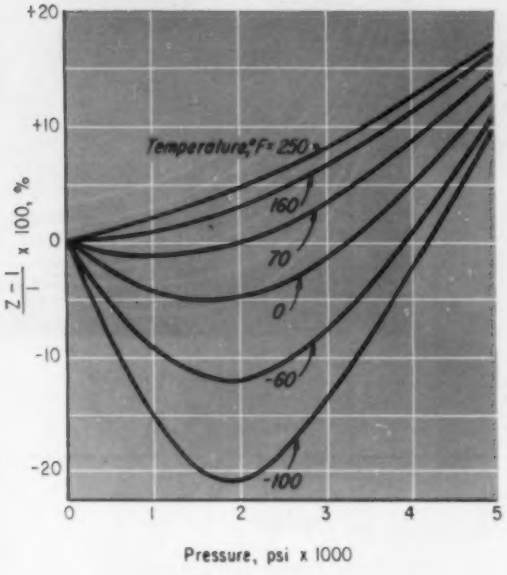
At higher air pressures, next page, the approximate equation does not apply because the velocity is not constant at all pressures for each temperature. The greatest variation is for −100 *F* air: sound velocity at 5000 psia is 1801 ft/sec, which is almost twice the value of 928 ft/sec based on $49\sqrt{T}$.

Viscosity

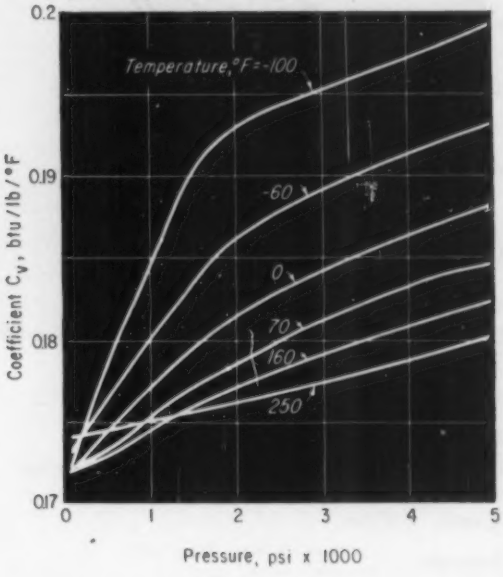
Absolute viscosity, μ, is a measure of the force, *F*, to shear a 1-ft cube of fluid at a specified velocity, V. $\mu = (F/A, \text{lb/sq ft}) \div (V/H, \text{ft/sec-ft}) = FH/VA$, lb-sec/ft². Alternate units, slug/ft, are obtained by replacing force *F* with its equivalent in mass and acceleration units.

(CONTINUED ON NEXT PAGE)

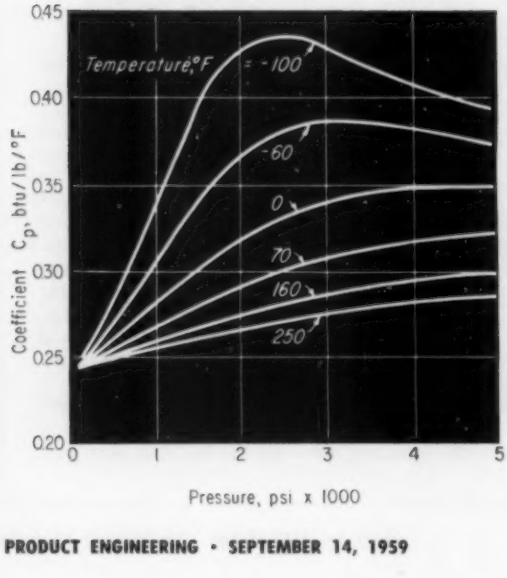
Compressibility deviation from perfect gas



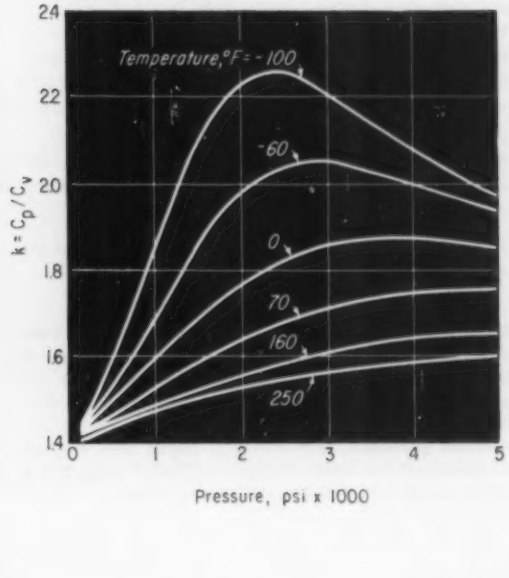
Specific heat at constant volume



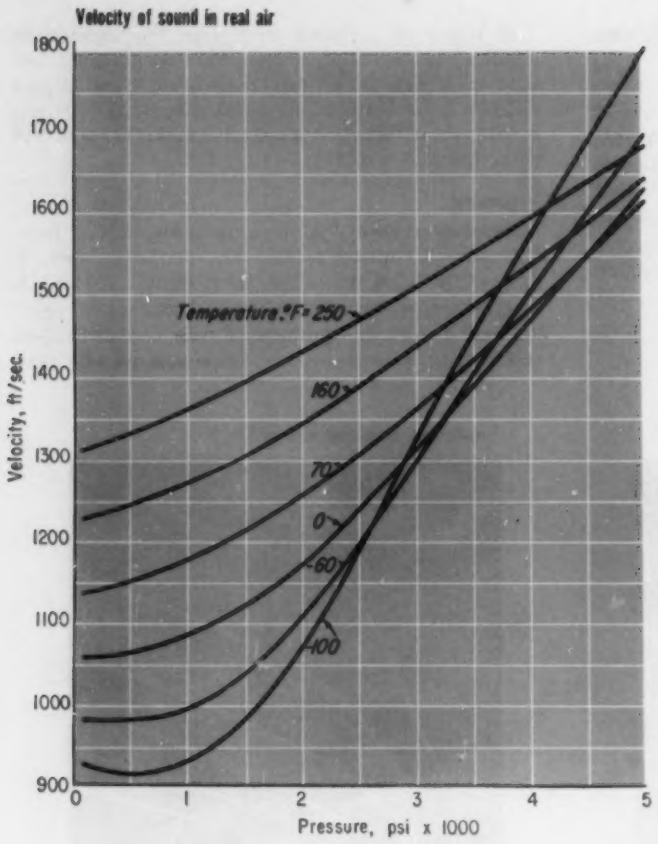
Specific heat at constant pressure

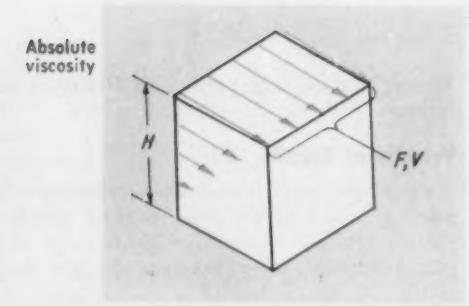


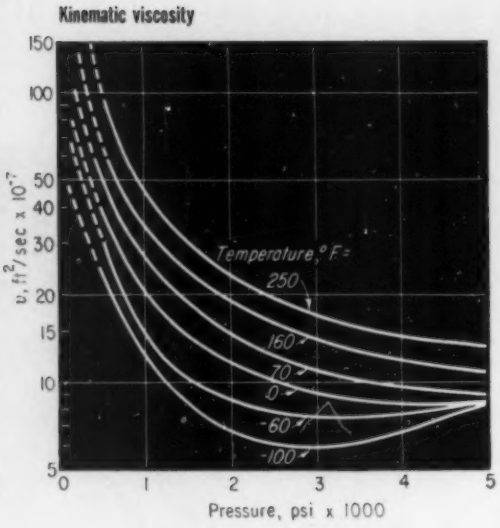
Specific-heat ratio



HIGH-PRESSURE AIR (CONTINUED)







Kinematic viscosity, υ, plotted above, is absolute viscosity, slug/ft-sec, divided by mass density, slug/cu ft, giving units of ft²/sec.

An Example

Find the properties of air at 3000 psi, 160 F. Compressibility factor Z is approximately 1.064, therefore deviation is plus 6.4%. Mass density = P/ZRT = (144 x 3000)/(1.064 x 53.3 x 620) = about 12.3 lb/cu ft or 0.381 slug/cu ft. Specific heat C_p = 0.287 btu/lb/F; C_v = 0.179. Ratio k = 0.287/0.179 = 1.61. Velocity of sound = 1433 ft/sec. Kinematic viscosity is 14 x 10^{-7} or 0.0000014 ft²/sec. Absolute viscosity = (14 x 10^{-7}) x (0.381) = 5.33 x 10^{-7} lb-sec/ft². In metric units, absolute viscosity is 5.33 x 10^{-7} x 47,880 = 0.0255 centipoise.

For REPRINT of above article, just check P4 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: The problems in designing actual systems are covered in a previous article by Mr. Brady, "High-pressure Pneumatic Circuits for Aircraft," Mid-Oct '55, p J-26. It discusses component selection, and gives answers to moisture problems at storage pressures up to 3000 psi.

Conversion of viscosity from metric to English units is given in the nomograph "Viscosity Conversion Charts," Aug '51, p 179, which covers both absolute and kinematic units.

8 *steps to better engineering writing . . .*

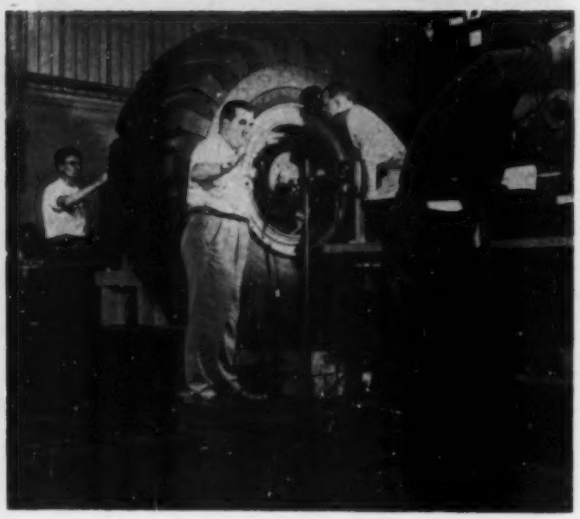
A down-to-earth guide for your daily working assignments, to help you communicate effectively and get action.

In this issue on page 45 is the second in our new weekly series of one-page lessons on writing more powerful memos, letters, reports, proposals. The first lesson in the Sept 7 issue showed how vanity and laziness must be faced down first before good writing can start. The second lesson in this issue tells why you must "Be positive, be brave." Next week's topic is "How to be Yourself."

Author Dick Koff, senior associate editor on Product Engineering's staff, puts on a good demonstration of his own technique in this series. He is not exhaustive; he hasn't followed the traditional format; he doesn't provide a simple formula that eliminates judgment. But he is terse and to the point—dealing with today's problems as you face them.

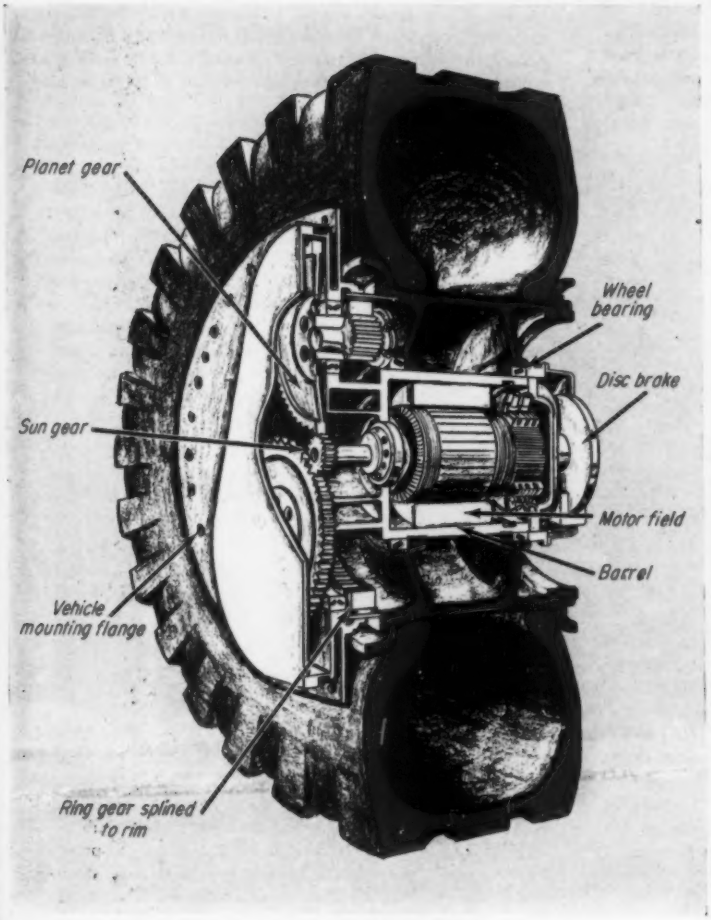
If you missed the first lesson, turn to the Sept 7 issue, page 21, then read the second lesson on page 45 in this issue, and watch for the third one next week.

DESIGN FEATURES IN NEW PRODUCTS



Hub Drives Its Own Wheel

Motorized wheel puts power where its needed, bolts to frame as a complete power package. High horsepower utilization is independent of operator ability.



Electric motor and drive are mounted in the hub of a 45-in. tubeless tire. The motor will develop 380 rim horsepower and four such units can drive a 125-ton vehicle 35 mph. Dynamic braking can then stop it in about three vehicle lengths. Either a diesel-electric generator, cable or trolley can be used as a power source. Produced by Locomotive and Car Equipment Dept, General Electric Co, Erie, Penna.

Flanged steel barrel . . .
is the heart of the motorized wheel. Motor and brake are mounted within the barrel, which doubles as the vehicle wheel axle and motor field frame. Polepieces of the dc series-wound motor are bolted to the inside of the barrel. The armature drives a planetary power train. An aircraft-type disk brake is mounted on the commutator end of the shaft.

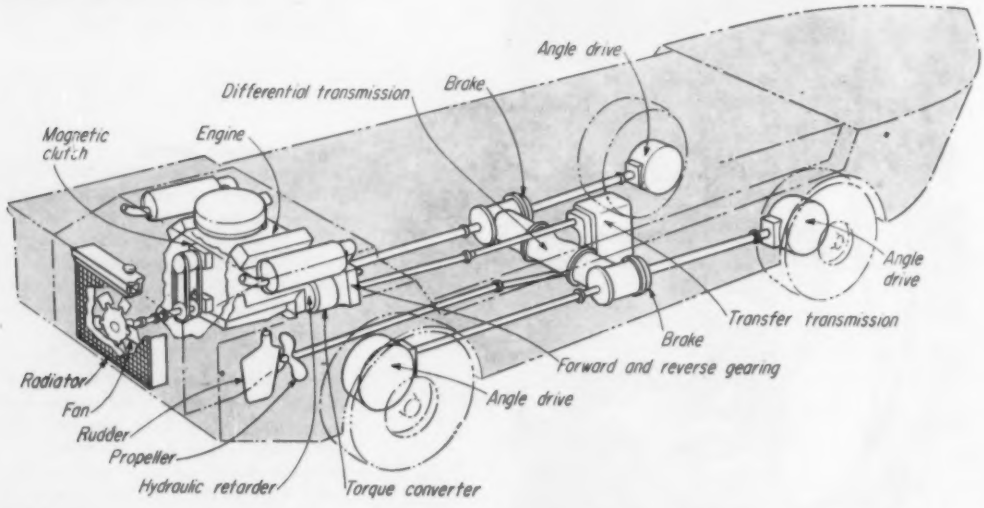
The mounting flange to which the motor barrel is attached forms part of the gear case. The armature is splined to a sun pinion shaft whose teeth engage three large planetary gears. The first reduction stage is on the vehicle side of the mounting flange wall in a recess in the vehicle body. Each of the three high speed planet gears is mounted on a pinion stub shaft whose bearings are in the motor mounting flange. Final reduction is from planet pinions engaging a ring gear splined to the wheel rim. The mounting flange supports the wheel loading through the barrel, provides means of attachment to the vehicle, and serves as part of the gear case. Four or more motorized wheels may be attached to any box containing engine, generator and control equipment to produce a truck.

Seagoing Vehicle Uses Industrial Components

Amphibious lighter uses stock parts to ease maintenance. Springless suspension saves 3000 lbs and reduces size of wheel wells.

Wheeled amphibian is capable of transferring five tons of cargo from shipside, through the surf, over sandy beaches to inland depots. Constructed of aluminum the craft uses a Ford industrial engine to power all four wheels on land and a propeller when afloat. Lighter, Amphibious, Resupply, Cargo (LARC-5) is produced by Ingersoll Kalamazoo Division, Borg-Warner Corp Kalamazoo, Mich.

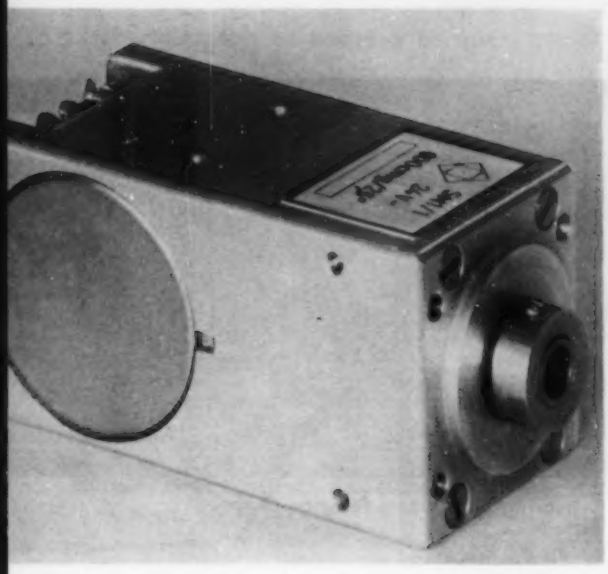
When afloat . . .
the cargo area of the LARC is nearly awash but removable canvas bulwarks keep water from damaging the payload. Raised portion at rear houses engine, torque converter, and cooling fan. Magnetic clutch disconnects fan during water operation. Ashore the canvas bulwarks are removed for easy loading or unloading. Previous lighters required cranes or hoists to load or unload box-like cargo holds.



Power train . . .
consists of a gasoline engine and its cooling system plus transmissions and drive shafting to supply power to all four wheels. The engine, radiator fans and air cleaners are all standard industrial units. The radiator and fan compartment is isolated from the rest of the hull to prevent seawater from entering the bilge system. A hydraulic retarder and torque converter, plus forward and reverse gears, are connected directly to the engine.

The differential-transmission assembly provides power to either the wheels or propeller or both simultaneously. Wheel brakes on the output of the differential-transmission are capable of holding a full load on a 40% grade. Drive shafts supply power to the four interchangeable angle-drive gear housings and then to planetary gear sets mounted in each wheel hub.

Rigidly mounted wheels depend on the large, low-pressure tires to absorb road shocks. Four-wheel hydraulic steering provides selective crab or oblique movement.



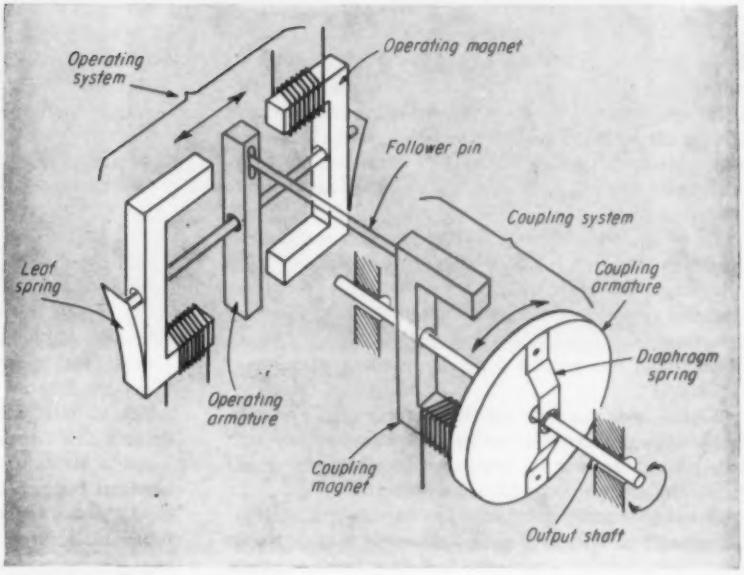
Step Motor Uses Two Armatures

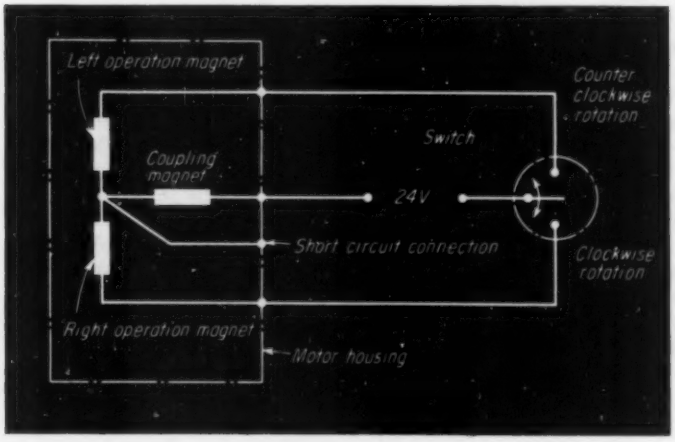
Dual magnetic system eliminates collectors rings and gears in sealed, instrument drive motor. Pulses of dc current are used to produce precise rotary steps as rapidly as 10 times per second.

Motor is used to control such regulating devices as variable resistors and variable capacitors. A torque of 14 in.-oz is produced with a power consumption of 6 watts. Step-by-step motor SM 1 is produced by Telefunken GmbH, Backnang/Wurtt, Germany.

Motor operation . . .

is a result of the interaction of the two magnetic systems. When the motor is energized current is introduced to one of the operating magnets and to the coupling magnet. The movement of the operating armature towards the energized operating magnet imparts a rotary motion to the coupling magnet and coupling armature attracted to it. The operating armature and coupling magnet are connected by the follower pin. When the energizing current drops, the coupling and operating magnets are de-energized and the leaf springs center the operating armature. The follower pin returns the coupling magnet to its original position while the coupling armature remains in its new position. The extent of rotary motion imparted to the output shaft can be adjusted between 1° and 3° by regulating screws.





Circuit diagram . . .

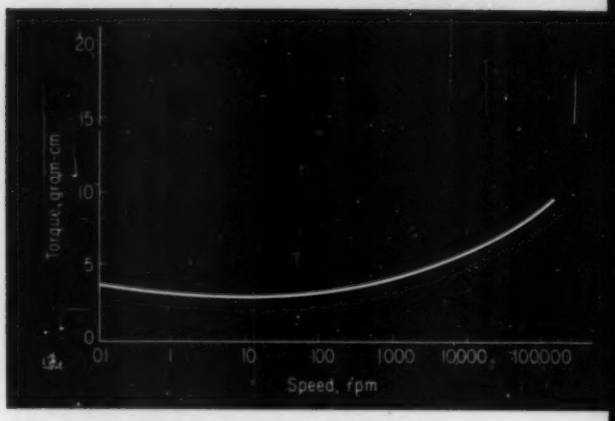
shows the simplicity of the operating principle. Incoming dc pulses flow through the magnet coil of the operating system and at the same time energize the coupling system. In the operating coil, building up of the magnetic field is delayed by about 30 microsec by means of a short-circuit winding. This permits the coupling armature to be attracted before the operating system starts to move. When the magnets are de-energized the operation is reversed and the delay caused by the short-circuited winding guarantees a complete and exact transmission of the rotary step motion to the output shaft.

these methods test

PERFORMANCE OF BALLBEARINGS

The special and commercial devices in this roundup will check bearings for torque, vibration and runout characteristics. A followup article will describe devices for measuring preload, radial and end play (see the Sep 28 issue).

BRUCE L MIMS *Vice-president, engineering*
The Barden Corp, Danbury, Conn



1. Bearing torque as a function of speed

The trend in recent years has been to subject a ballbearing to functional tests that will determine such factors as torque, vibration, runout, preload, radial-play and end-play characteristics. These factors, except for runout, do not relate to standardized ABEC dimensional tolerance grades of the Anti-Friction Bearing Manufacturers Assoc.

The table on a following page summarizes commercial equipment available for measuring torque and vibration in bearings; the rest of this article discusses the basic principles of commercial testers and special devices for measuring runout.

Functional test needed depends on the application—for example:

- Gyroscope rotor bearings that deform axially or radially by a few millionths of an inch can cause serious gyro drifts. Also, the bearing can generate vibrations which disturb the electronic pickups on the gyro.
- Synchro bearings must have low friction, yet must be stiff enough radially and with sufficiently accurate concentricity to hold an airgap of a half-thousandth between rotor and stator. The least bit of dust or debris can cause trouble here.
- Memory drum bearings must have runout held consistently to 50, 20, or even 10 millionths of an inch to permit proper transfer of stored magnetic pulses to pick-off heads. The same low runout is required in many machine-tool spindles.
- Aircraft cooling turbines require speeds in the 100,000-rpm range along with temperatures of 300 to 800 F and even higher. Dental drills in some cases run 350,000 rpm.

Thus, each application has one or two functional characteristics it needs most, with others of secondary or negligible importance. To meet the need, a welter of instruments has sprung up for evaluating ballbearings by one method or another. Most of them are covered here. None of these tests determine the expected life of a bearing. When loads and speeds are known, fatigue failures can be predicted statistically for entire populations of bearings but there is no inspection which can screen out fatigue-prone bearings from the long-lived ones.

Lubricant and retainer failures also are unpredictable. If bearings meet functional specifications, there is usually no warning until a few hours before disaster sets in.

TORQUE TESTERS

Torque of a ballbearing is a complex function in which load, coefficient of friction, material constants such as elastic modulus and Poisson's ratio, contact angle, number and size of balls, and raceway curvature combine to provide the basic low-speed torque. To this must be added the retainer friction, and the lubricant contribution which is itself a function of speed, viscosity, and fluid density. To complicate matters further, with increasing speed a ballbearing develops a hydrodynamic oil film between balls and races which slightly reduces the friction. At still higher speed, energy required to churn the lubricant increases the over-all frictional drag of the bearing. The speed-torque curve in Fig. 1 shows how torque drops slightly before increasing roughly with the $\frac{3}{2}$ power of speed.

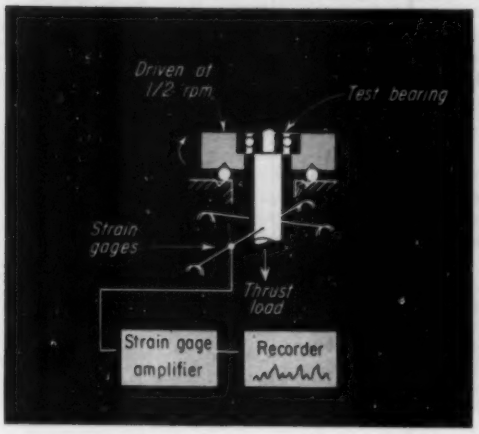
These effects can be calculated with fair accuracy as a result of theoretical equations and empirical constants. To test quality of the bearing, however, it is necessary to agree that certain conditions must remain constant: for example, direction of applied load, type of lubricant and temperature, and, to some extent, speed.

Continuous-torque types

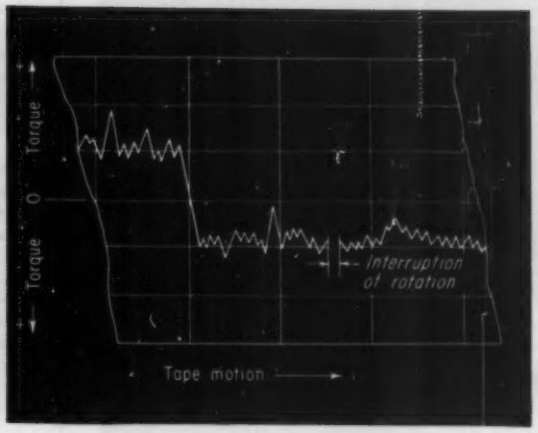
Agreement by the torque subsection of the American Ordnance Association's Instrument Precision Ballbearing Section, on the points to be kept constant, led to development of the MIL-ST-206 torque tester with provisions for certain loads, axis position, quantity and quality of lubricant, environment and test speed. Fig. 2 is a diagram of this device.

Basically, the outer ring of a ballbearing is supported

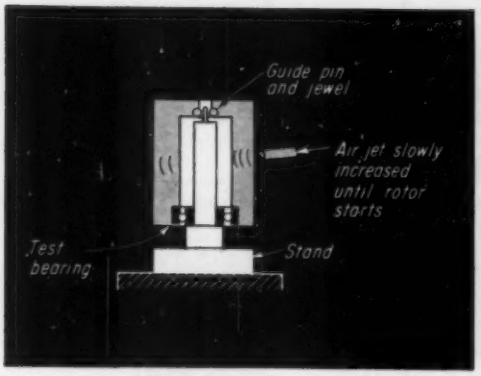
Determination of bearing torque



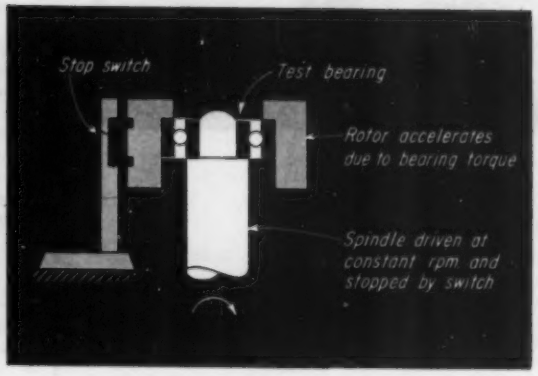
2. MIL-STD-206 Tester



3. Typical torque trace



4. Starting torque tester



5. Mass-acceleration torque tester

and rotated while an axial load is applied to the inner ring, which is restrained by a strain gage force-measuring system, with the output amplified and recorded as shown in Fig. 3. Usually the bearing is tested for one or two revolutions, with the record showing hundreds of cycles of increasing and decreasing torque.

This waveform is the product of a combination of surface and geometric irregularities in balls and raceways superimposed upon sliding friction. Any point along the trace might constitute a starting-torque occurrence if the ballbearing were stopped and then started in this position. Note in the illustration that after stopping, the trace picks up precisely where it left off, whether interruption represents a relatively high torque value or a low one. Any point on the trace is therefore a "starting torque" value, but any start must obviously be preceded by a stop; the chances of stopping at a point of high torque are in most systems much greater than stopping at low torque.

Starting-torque Tester

With starting-torque measuring devices, Fig. 4, more high starts are measured than low starts. In this second major type of torque tester, a stationary stand supports the inner race; the outer race in turn supports a rotor which applies a thrust load to the bearing. Increasing torque is applied to the rotor by an airjet or eddy-current device until the rotor begins to turn. At this point the impelling torque is noted as the starting-torque value. Because the rotor usually has a fairly high polar moment of inertia, there is considerable rotation following any given start, perhaps two to three revolutions. Therefore, successive readings on a starting-torque tester are really random samplings from many ballbearing revolutions, prejudiced somewhat toward the higher values. In contrast, the continuous-torque tester samples every possible starting torque (an infinite number) within one or two revolutions of the ballbearing.

There has been much debate over the merits of these two devices. Both provide useful information. In general, the continuous-rotation type is more sophisticated instrumentation; it not only measures ceiling torque, but also helps find the source of difficulty in defective bearings. The starting-torque device, however, is simple, sturdy, inexpensive. Both are slow workers—a disadvantage where a large and continuing volume of bearings must be tested. Torque testers available commercially are summarized in the table on the next page.

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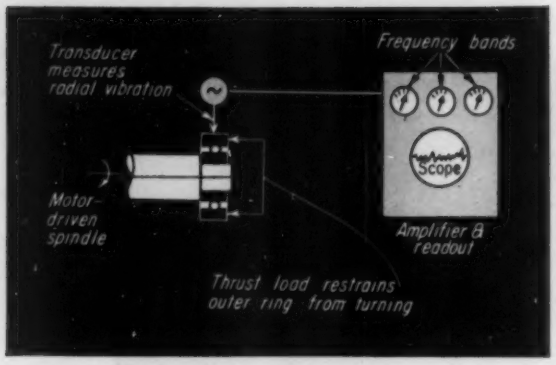
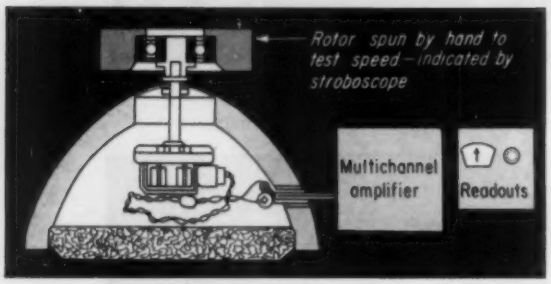


6. Spindle-driven Vibration Tester



7. Smoothness (vibration) tester

Other Types

There are many subspecies of torque testers, often combinations of the two main types. For example, a pulsing device in which a torque of known amplitude and duration is applied to a rotor supported by the test bearing. The number of times this pulse is applied per revolution of the rotor is a function of torque, but the relative importance of starting torque and running torque is difficult to evaluate. In the "mass-acceleration" type, Fig. 5, the inner ring is rotated while the outer ring, which supports the rotor, is allowed to accelerate; torque is measured by the length of time for the rotor to complete one revolution.

VIBRATION TESTERS

Measurement of vibrations generated by ballbearings is more complicated than torque testing. There are two main purposes for vibration testing: first, a quick means of judging smoothness of operation and bearing cleanliness; second, a means of predicting the vibration which a ballbearing will induce in its application. One difficulty is the effect of resonance and damping from clamping and housing or mounting on the shaft.

Spindle-driven Types

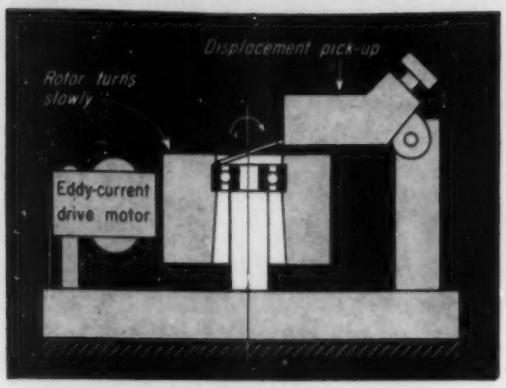
Testing the vibration output of the bearing as a measure of its quality has progressed somewhat in recent years. Originally the noise of the bearing was observed by ear, stethoscope or microphone while the bearing rotated. Now, a transducer is placed in contact with the ballbearing and the vibration signal amplified, sometimes filtered, and observed on a meter or oscilloscope, Fig. 6. However, many of the original difficulties with such devices remain,

Manufacturer	Designation	What It Measures	Load, grams
Eclipse-Pioneer	=13716-1-A Torque Tester =13717-2-A Automatic	Starting torque	75 or 400-gm thrust
Sunshine Scientific Instrument	=25 Ball-brg. Torque Tester (Similar to GE Torque Tester)	Starting and running torque as continuous function	75 or 400-gm thrust
Asch Equipment Company	MIL-STD-206 Torque Tester		75 or 400-gm thrust
	Larger Model than MIL-206		Heavier than above, thrust
Fafnir Bearing Company	Automatic Torque Tester		30 to 1000-gm thrust, continuously adjustable
The Barden Corporation	Torkintegrator		75 or 400 gm
Control Instruments Co.	Mass-Acceleration Torque Tester	Integrated friction torque	75 or 400 gm, or other thrust loads as required
Sperry Gyroscope Co	Peak-torque Tester T 411683	If bearing exceeds preset starting torque	75 or 400 gm
Leitch-Huard Corp (New Departure)	Vibrameter	Axial component of vibration	To match bearing being tested
The Baker Company Inc	The Baker United Airlines Torque Tester	Starting torque, running torque, bearing noise	8 gm, average
The Barden Corporation	SmoothRator	Axial vibration	Depends on bearing size
Micrometrical Mfg Company	Anderometer	Radial vibration	Thrust load applied manually or with adjustable fixture
Bearing Inspection Inc	Electronic Brg. Analyser, Model BA-20	Vibration	Radial load 1 oz to 5 lb

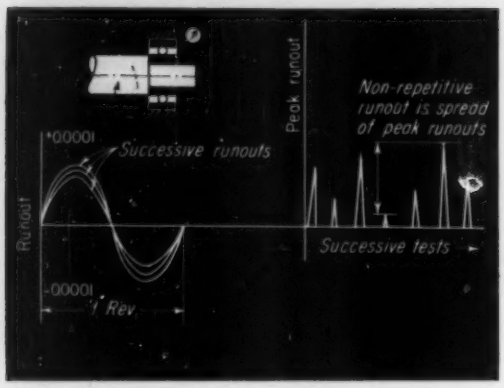
AND VIBRATION TESTERS

Range, milligram-millimeters	Speed of Use, stated by manufacturer	Bearing Size Range, in.	Meets Gov't Specifications? (quotes by mfr)	Price	Readout	Remarks
200 to 15,000	40 bearings per hour	0.1 to 1.375 OD	"No, but purchased and used by military"	On request	Dial numbers related to torque and go, no-go lights	Torque, increased by air jet until rotor starts turning, is observed or read out automatically.
3000 to 30,000 with go, no-go lights; 700-0-700, 50,000-0-50,000 with recorder	One complete revolution at either ½ or 2 rpm (see remarks)	⅛ ID min 1½ OD max	"Conforms to the tentative MIL-STD-206"	$2730, plus $977 for recorder; $50 per extra adapter	Continuous recording and go, no-go lights	Outer ring rotates while inner ring is restrained by force-measuring device. Signal amplified and recorded. Limit switches or go, no-go lights are used. MIL-STD-206 specifies test cycle of 2 revolutions at ½ rpm. With loading time this allows inspection rate of about 12 brgs/hr. However, most testers are adaptable to 1-rpm test speed, and some manufacturers recommend this, resulting in higher "Speed of Use" values tabulated.
200 to 20,000	12/hr	0.055 to 0.50 ID	Yes: MIL-STD-206	On request		
Higher torque than above	60/hr	0.055 to 6.0 ID	"Similar in principle to MIL-STD-206"	$1800 to $3800; $100 per extra adapter		
Ranges: 1800, 3600, 9000, 18,000	50/hr @ 2 rpm 1 rev cw & ccw 100/hr @ 2 rpm ½ rev cw & ccw	¼ to $1\frac{3}{16}$ OD	"Meets test requirements of MIL-STD-206"	$4950 with 3 adapters; $75/extra adapter		
20,000	30/hr with go, no-go lights; 20/hr with recorder	⅛ bore to 1⅜ OD	"Conforms to MIL-STD-206 except for test speed, which is 6 rpm"	Not commercially available		
Any	300/hr	⅜ to ¾ OD (standard); to ⅛ OD (special)	Refer to mfr for correlation with MIL-STD-206 test results	$750	Dial reading	When inner ring rotates, friction drags outer ring and supported mass. Time measured for one outer ring revolution.
2500 to 30,000	30/hr	Up to 1 OD	"Compatible with MIL-STD-206"	Not commercially available	Go, no-go lights	Starting torque preset by means of torsion wire. Torque exceeded when contact broken.
Not applicable	About 120/hr depending on bearing and operator	⅛ to $\frac{3}{16}$ bore ⅜ to $\frac{5}{16}$ OD, others are specials	No	$575 plus $12/adapter and $15 for master bearing	Meter scale & 3 trigger lights	Correlates with "hand-run test."
30 to 4000	Up to 30/hr	0.055 to 0.750 ID; up to 1.625 OD	No	$900; $12/adapter	Meter readings in arbitrary units: volts x 2 = (torque)	Torque to rotor increased manually until bearing starts. Bearing noise read on meter or recorded.
Not applicable	100/hr	Up to 1 OD	"No, though specified and used by military"	$600; $10/extra adapter or $30/month rent	Rms meter reading for overall roughness; counter registers defects	Measures axial component of bearing vibration, hence smoothness of operation.
Not applicable	3000 per 8-hr shift	$\frac{5}{16}$ to 6 OD (larger model also available)	Yes: MIL-B-17931A	$6500 to $7000; $85/extra adapter (average)	3 dial readings showing a function of radial vibration for various frequencies	Designated by MIL-B-17931A to select annular ballbearings for quiet operation. Pickup head bears against OD of rotated bearing.
Not applicable	120/hr	⅜ to 5 OD; up to 12 OD with auxiliary drive	Are none	$4600; $25/adapter. Each adapter accommodates 3 bearing sizes	Rms and peak vibration; repetition rate of peak; also limit light	Brg. rotated at 40 to 300 rpm. Vibration through support spindle is amplified and displayed on meters or oscilloscope

Runout Testers



8. Face runout (wobble) tester



9. Testing of nonrepetitive runout

such as: (1) thrust load applied in a nonuniform manner, with uncertain misalignment or magnitude; (2) resonances induced by the pick-off itself; (3) vibration or noise from the drive spindle, (4) changes of ball-spin axis orientation within the bearing from trial to trial, resulting in large changes in indication. All these variables lead to poor repeatability.

Moving-coil Types

Developed primarily for instrument bearings, with an eye toward overcoming deficiencies of the spindle-driven type, these vibration testers use a moving-coil pickup which supports the inner ring of a ballbearing. A small rotor attached to the outer ring is rotated above the test speed and allowed to coast through the measuring range. Fig. 7 shows the device.

Spurious vibrations from drive spindles or motors do not contaminate the measured signal. Axial vibration induced in the inner ring is transmitted to the pick-off, amplified and then treated in various ways to produce a readout. For instance, over-all roughness of the bearing is sometimes read on a single meter as an rms signal, while sharp transients caused by dirt or defects within the bearing are counted.

Although this type of device reads vibration, rather than friction, it correlates quite well with the pattern of torque variations in Fig. 3. If the torque trace is rectified and displayed as an rms value, torque will correlate with vibration amplitude. Defects causing the sharp torque peaks will similarly produce vibration transients.

Advantage of this vibration tester over the torque tester is in its speedy indication of pass-fail data. While only 12 bearings per hour can be tested according to the MIL-STD-206 method, about 100 per hour can be handled by a vibration tester.

Both types of vibration testers are useful. Testing of instrument bearings requires considerable subtlety of selection among bearings; the spindle-driven tester is used primarily on spindle and motor bearings where the basic objective is to screen out fairly obvious defects.

RUNOUT TESTERS

Problem of measuring face runout or radial runout is not difficult where tolerances are 0.000,1 or 0.000,2 in. Real difficulty arises when tolerances of 20 to 50 millionths of an inch are required, as with certain rotor bearings for gyroscopes. Here, even the presence of an operator is a problem, so automatic motor-driven devices have been developed. Most of these devices, such as the one shown in Fig. 8, are developed by the bearing manufacturer for his own use.

The bearing user has done little checking of these characteristics in the past. Recently, however—for memory drums and some particularly critical machine-tool spindles, it has become helpful to measure "nonrepetitive runout," by equipment shown in Fig. 9.

Because a ballbearing has no absolute center of rotation the geometric center of the inner ring describes a polygon as the inner ring rotates. This occurs mainly because the inner ring settles down between two balls and rises up on one ball as the bearing rotates under radial load.

This effect is mitigated by axial load or preload, but nevertheless sets a low limit of rotational repeatability. Out-of-round balls as well as waviness of raceways add a second order effect—in departures from true circularity. These effects are in terms of millionths of an inch. The limit of nonrepetitive runout is approach with an infinite number of zero-dia balls; the manufacturing limit, by perfectly round raceways and perfectly spherical balls of equal size.

The practical value of minimizing nonrepetitive runout is in truing a grinding wheel, a spindle, a memory drum—or in any critical balancing operation. The low limit is established by the nonrepetitive runout of the ballbearings.

While a few ballbearing users and manufacturers have developed their own nonrepetitive runout gages, there are no such devices commercially available.

A reprint, combining the above and its following article, will be offered in the Sep 28 issue.

EDITOR'S NOTE: For lubricants and materials for ball bearings see:

Guide to Lubricants for Instrument Ball Bearings, June 6 '58, p 66. Discusses properties and performance characteristics of 42 modern lubricants.

Instrument Bearings for 300 F and Up, Feb 3 '58, p 72. Tells what happens to ball bearings at these temperatures and lists special material and lubricants.

PAINLESS DRAWING CHANGES

Here is a practical idea, even for a small design department: set up a non-engineering service group to keep drawings up to date.

JESSE W BORN
Iron Fireman Manufacturing Co

Drawing changes are inevitable. The product hasn't been designed that cannot be improved, and improvements mean changes whether the ideas come from the model shop, drafting, production, test or tooling.

Traditionally, the product designer has handled these change requests because he's the man who knows most about the design. But there are a number of reasons why he is the man least suited for the job.

No time for changes

The trouble starts when an engineer is asked to process a change in a product he designed months or years ago. He no longer has the personal contact with the product that he had in the development stages. In those days he would have made the change himself or directed the draftsman to do it. Now he's forgotten the details and the problems. He must review and reconsider—and interrupt today's pressing problems to do it. As a result, he puts it off and change requests pile up.

Lack of time is not the only reason for delay. Promotion, sickness, death, cause personnel changes. The engineer who handled a project two years ago may not be with the company. The new engineer, who probably inherited a neat little bundle of notes and change suggestions from his predecessor, simply adds the new ones to the stack. He's waiting until he's more familiar with the project before he does anything about it.

But these things that are put away as rainy day jobs frequently form large muddy puddles.

The answer is to establish a small group whose duties are limited to processing change requests. These need not be engineers; they can get the answers to technical questions from the engineers they are servicing.

The people and the system

At least three people will be needed for a change group in the average small engineering department: supervisor, draftsman, and clerk-typist. These can keep pace with as many as 18 engineers and draftsmen. Ideally, the supervisor should be a man with some drafting experience, a knack for details and a lot of common sense.

In his investigation, the supervisor will bother many people. He will question the detailer who omitted a dimension, and he will ask the designer why an expensive part is specified when a cheaper one will do. But this is his job and it is far better to have him bothering people than to let those change requests stack up like cordwood. Draftsmen learn to be more specific, and engineers become more observant after they have been questioned repeatedly about missing part numbers or notes that leave too much to the imagination of the shop man.

The procedure for handling change requests will vary with each organization but these basic methods apply in nearly all cases.

- A request form is prepared for all foremen and supervisors to use so anyone, with his immediate supervisor's approval, may submit a change request. The men who sweep the floors, move the scrap, and drive the lift trucks can make valuable suggestions if given encouragement and supplied with the proper forms.
- Once written, the change request is sent to the supervisor of the change group. He studies it, either by itself or with other similar requests, and if the change seems reasonable, he asks department heads about the feasibility of the change. On the basis of this investigation, he will approve or reject, perhaps confirming this decision with the chief engineer.
- If the request is rejected, the supervisor explains the reason for rejection to the person who initiated the request. This shows the originator that his request was considered—not thrown away.
- A written explanation of the change is distributed to interested departments. Whatever the form may be called, the purpose is to tell exactly what was changed, why it was changed, and what is to be done with existing stock and work in process. This explanation is written by the change supervisor because he, more than anyone else, knows the reason for the change and the effect it will have on the organization and the product.

This service function will, of course, take a bite out of the engineering budget. But the expense will be more than offset by saving the time normally spent on such routine matters by expensive engineering talent. In addition, it will save the expense of errors that go unnoticed and also insure that all worthwhile suggestions are quickly and conscientiously evaluated. ■

survey method EVALUATES RESIDUAL STRESSES IN GEARS

The higher the compressive residual stresses in a gear tooth, the better. But which hardening treatment and combination of materials give best results? Answers are found in data supplied by these authors, with details on their test method.

E T BERGQUIST, *chief metallurgist*
Western Gear Corp, Calif
S M LENHOFF, *weapons system manager*
Army's Ordnance Tank-automotive Command, Detroit

Experience based on repeated tests now gives us confidence in a shortcut method for surveying the residual stresses retained at the surface of a gear tooth. The method is the preliminary strain gage step to the standard beam-dissection technique. By giving a rough but quick picture of the stress situation, it promises broader consideration of residual stresses in design especially for critically stressed gears.

The multiplicity of methods of carburizing and hardening, coupled with the variety of materials from which gears can be made, make complete detailed surveys impractical. So the residual stresses retained after heat treatment are usually ignored in design. Yet for highly loaded gears they must still be considered.

With the complete beam-dissection method, you part a tooth from the gear, grind it to a predetermined size and then progressively grind away small increments from the surface. As material is removed, an unbalance of the remaining residual stresses causes the piece to warp. The curvature of this deformation is read and the new stress at the new surface can then be calculated. The entire series of grindings and readings gives a complete picture of stresses within the tooth.

The survey method which needs only two strain-gage readings—one taken on the specimen tooth before it is cut off the gear; the other, after it has been trimmed for dissection will give an approximation of the residual stress. At this stage, it already shows distortion because of adjustments from internal stresses. From the initial strain, a calculated base stress, S, can serve for quick comparison of the residual stress.

That these basic stress values can be depended upon was established by working with a large number of gears. The tests showed that the final corrected values of surface stress determined by further dissection were usually within $\pm 10{,}000$ psi and at most within $\pm 20{,}000$ psi of the value for basic stress.

The S values for the various materials and heat treatments are given in the accompanying table. These data, when categorized and compared, show the following helpful guides to design:

- Some values of residual stress when corrected, were as high as 70,000 psi immediately beneath the gear tooth surface. This means that, for highly stressed gears, compressive residual stresses can make substantial difference in design calculations and load carrying ability.

- The depth of case hardening has a varying influence on the magnitude of compressive residual stress depend-

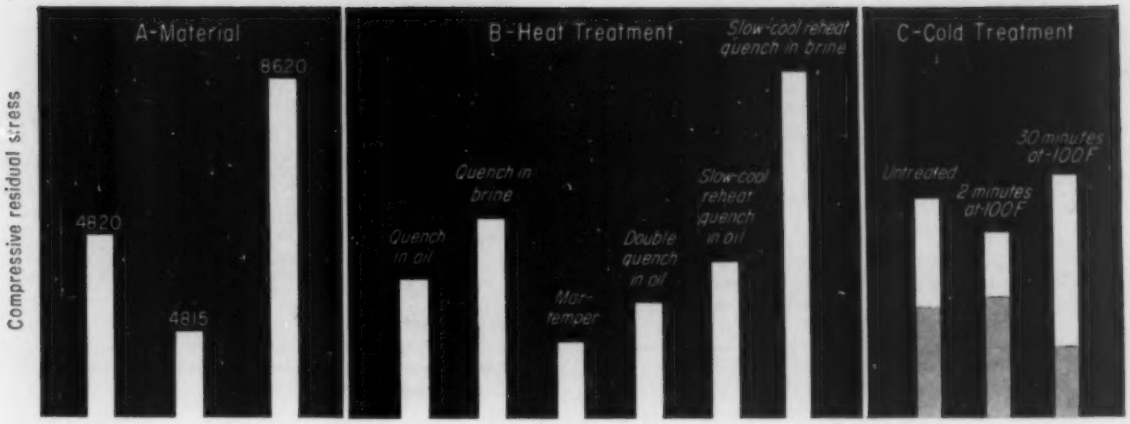
Why Test for Residual Stresses?

When you heat-harden a gear for wear resistance, it gains in mechanical strength—and therefore in ability to carry load. The gear will also perform better now because of the increased residual compressive stresses introduced.

The heat treatment is given in either of two ways: (1) selecting a material that will naturally quench-harden, heating only the surface, then quenching; (2) taking a steel that normally would not harden, infusing carbon into the surface, then quench-hardening the entire gear. In this latter case, only the surface, which has sufficient carbon, becomes harder.

Usually, the mechanical properties decide which gear material is to be used. Then a surface-hardening heat treatment is specified for wear resistance at surface of the tooth. Each material has its own heat-treat cycle for such hardening; sometimes more than one cycle is needed, depending on properties desired.

Because of their complex shape, and difference in properties from hard case to soft center, residual stresses in gears can only be determined by empirical tests.



Sensitive test . . .
gives relative compressive residual stress values. Method requires only 2 sets of strain-gage readings and appraises different process treatments as well as different materials. (A) 3 steels identically carburized and hardened; (B) different heat treatments for same 8620 steel with 0.080 in carburized case; (C) 4820 steel brine quenched and given cold treatment for dimensional stability. Shaded areas show stress reduction given by tempering at 350 F.

ing on the material and the specific heat treatment. However, optimum residual stress cannot be the sole criteria for specifying case depth. More important is the depth required for adequate carrying of the applied loads.

• If possible, specify the heat-treat method which gives the required hardness and the highest residual compressive stress. Examples are: oil-quenching a gas-carburized gear directly from the carburizing furnace (normal commercial practice) gave the lowest values of S. Slow-cooling the carburized gear, then reheating and quenching in oil (standard practice for aircraft gears), gave higher results; and the same procedure, but quenching in brine instead of oil, gave even higher compressive stresses. (Brine quenching should only be specified when sufficient tests have determined that cracking does not occur during the quenching). Pack carburizing, although equivalent to gas carburizing for a shallow case, gave relatively lower compressive stresses for the deeper case.

Test data showed that the normal practice of a stress-relief temper at 325 F after sub-zero treatment reduced the compressive stresses. Sub-zero treatment is often used for gears with high alloy content to insure more complete transformation of retained austenite. This is done primarily to insure dimensional stability in the final product.

For the Complete Stress Picture

Those samples which showed high S values were given the full beam-dissection treatment. The complete pro-

Data Used for Appraising Residual-stress Potentialities

S, psi x 1000 (in compression)

Material	4820		4815		8620	
Case Depth, in.	0.050	0.080	0.050	0.080	0.050	0.080
Gas–carburized gears						
Quench—oil	3.59	8.01	7.93	9.13	2.83	12.75
Quench—brine	13.85	16.62	14.58	13.56	13.21	26.30
Martemper	18.39	26.23	18.65	3.77	10.26	5.99
Double quench—oil	11.40	28.50	16.00	2.51	16.17	8.38
Slow—cool, reheat, quench—oil	7.06	21.83	8.43	1.02	25.80	16.32
Slow—cool, reheat, quench—brine	11.87	20.83	17.50	6.72	16.63	42.70*
Pack–carburized gears						
Slow—cool, reheat, quench—brine	11.85	3.65	13.78	11.47	13.11	7.11

*When case depth was increased to 0.100 in. the basic stress, S, dropped to 22.00

Calculating stresses from a beam-dissection test

Basically, beam dissection is a relaxation method which relies on the internal stresses to readjust to equilibrium after each layer is removed. This shows up externally as a change in length, curvature, twist or other distortion. In a simple rectangular beam, simple uniaxial stresses can be calculated by the formula.

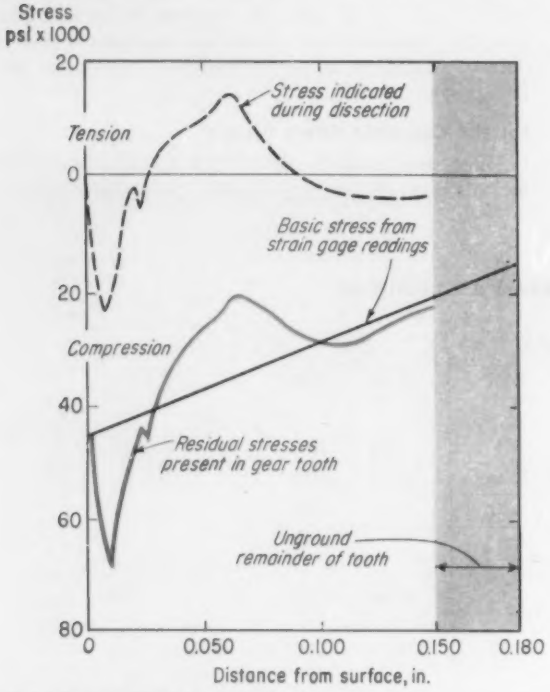
$$S_z = \frac{E(t-z^2)C'(z)}{6} - \frac{2E(t-z)C(z)}{3} + \frac{E}{z}\int_0^z C(z)\,dz$$

E is elastic modulus, C (z) is curvature and C' (z) is the first differential or slope of the curvature at the given depth z; t is original thickness of the bar.

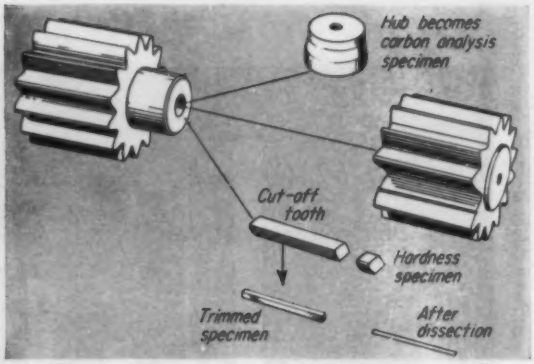
cedure for finding the stress pattern was as follows:

All the samples were 4-pitch, 14-tooth gears (approximately 4 in. diameter). They had a 3½-in. face width and 25° pressure angle, and were identically made. Three teeth on each gear, about equally spaced, were selected and locations for the strain gages scribed through a templet. Strain gages were then attached to the thoroughly cleaned surface and waterproofed for protection from subsequent wetting. At this point, strain-gage readings were taken on the intact gear to determine the zero reading. Then the gear was cut up as shown in the diagram above.

The extended hub was cut off for carbon analysis; then the gear was positioned in a jig and the selected



Complete residual stresses . . .
as distributed in gears. Pattern here is for 8620 steel, gas carburized with an 0.080 in. case. Hardening procedure was slow-cool after carburize, reheat, and quench in brine.



Shortcut method . . .
involves placing 2 strain gages on the geartooth, cutting it off and measuring strain. Complete stress picture is obtained by beam-dissection.

tooth was parted. Next a ½-in. section was cut off from one end. Then the remainder was made into a finished dissecting specimen. Here, another set of strain-gage readings was taken. From the change in length and curvature the basic stresses were calculated. These were denoted S. The strain gages were removed and the specimen dissected by grinding off 0.001-in. layers, starting from the gear surface. The curvature in the specimen after each layer was removed was used to calculate the subsurface stress-gradient plotted as shown in the dotted curve in the figure below. Then S was added; the algebraic addition of the straight line and curve gave the corrected curve shown in the solid line.

The opinions expressed in this article are those of the authors and do not necessarily reflect those of the Ordnance Corps.

EDITOR'S NOTE: Other recent articles on techniques for analyzing stresses, both residual and applied:

Acoustoelasticity, July 20 '59, p 57, presents a new method—polarized high-frequency sound waves can check on residual stresses without need for plastic models, or destroying the part.

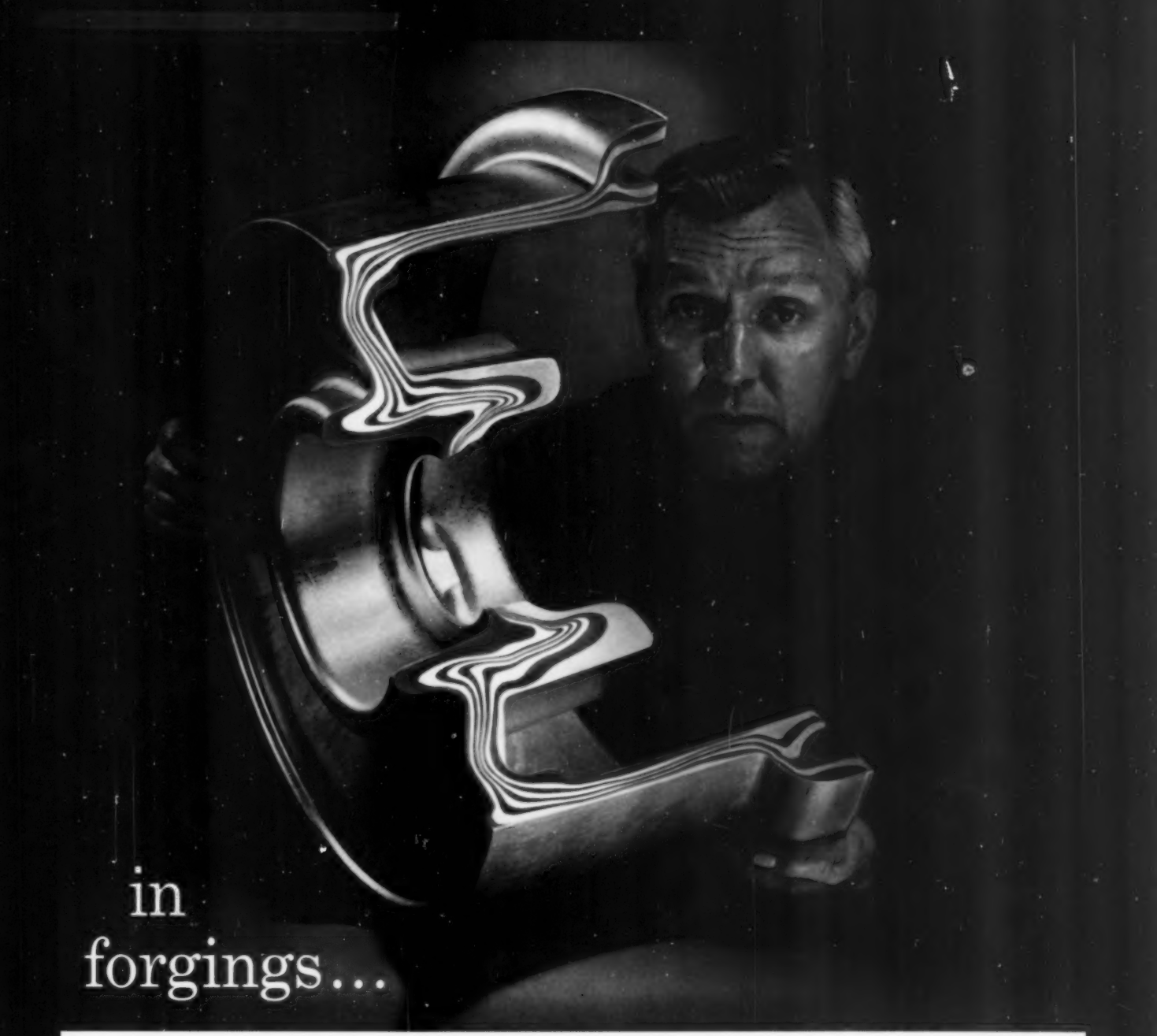
Finding Stresses in a Pressure-vessel Head, July 6 '59, p 57, gives calculations for finding biaxial stresses in a pressure vessel by placing strain gages on outside surface.

PhotoStress Analysis, Mar 2 '59, p 43, describes latest developments in a new photoelastic technique introduced in a previous PRODUCT ENGINEERING special report.

How to Measure Principal Stresses, Oct 14 '57, p 101, shows how to get the most out of strain-gage analysis.

Design Digest Now Ready

Product Engineering's annual Design Digest is now in the mail to all subscribers. This year's Digest, more than 550 pages, includes 56 articles in 10 sections on General Engineering, Metals and Alloys, Nonmetallic Materials and Finishes, Fabrication and Production Processes, Power Transmission, Mechanical Parts and Design Analysis, Fastening and Joining, Motors, Engines and Controls, Electrical and Electronic Components, Hydraulic and Pneumatic Equipment. New feature this year is an expanded sectional listing of abstracts.



d'ARAZIEN

Alcoa puts the metal where you want it

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Logically enough, rugged aluminum forgings were elected for the job. Then came many hours of Alcoa skill in die design, demonstrated in the remarkable zebra stripes visible in the cross section. They represent the aluminum grain flow* and illustrate how the tough aluminum grain is forged to withstand the shock loads of landing impact, plus the cyclic fatigue of rotation, all with a wide margin of safety.

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Think of Alcoa® Forgings when strength and lightness are rigid design requirements. Producing a complete line of forgings, Alcoa forges more large and complex shapes than any other supplier. Aluminum Company of America, 919 Alcoa Building, Pittsburgh 19, Pennsylvania.

**The patterns shown in the illustration were produced in Alcoa's Research Laboratories as part of a study of grain flow developed by the dies used to forge the DC-8 wheel.*

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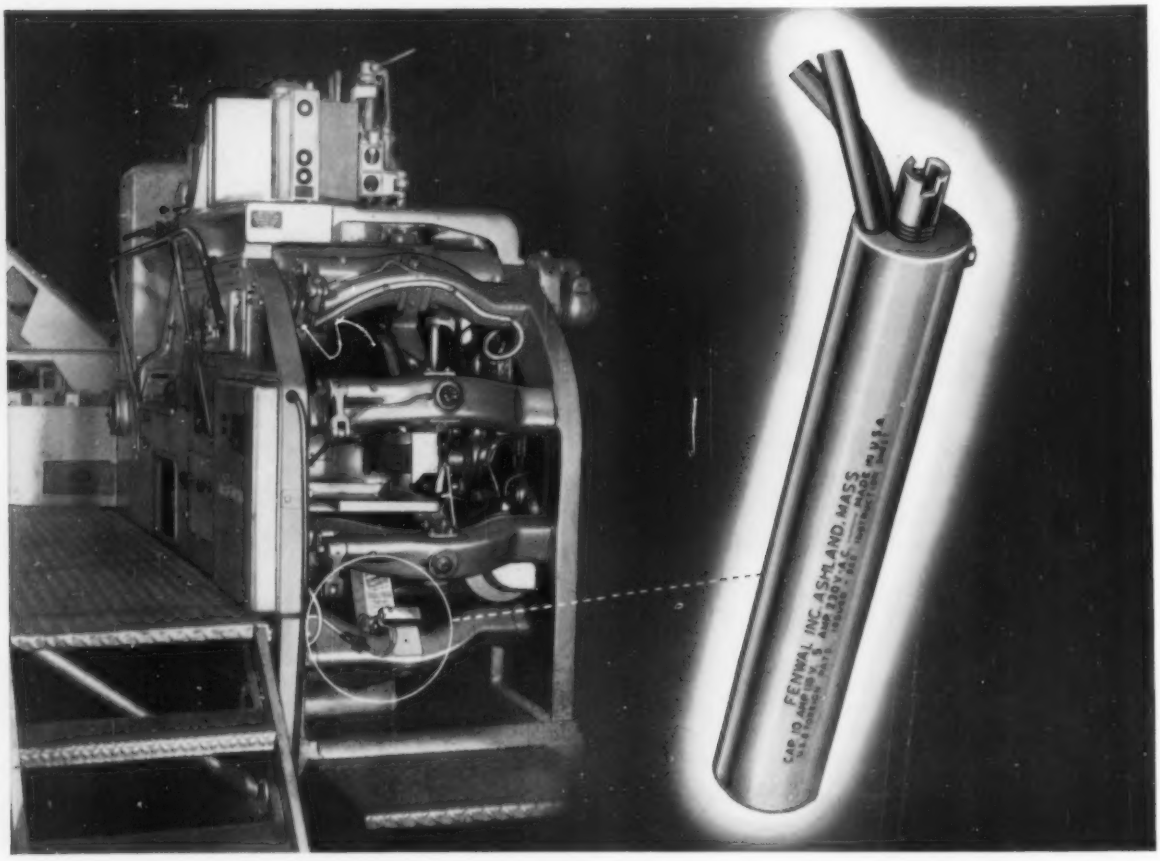
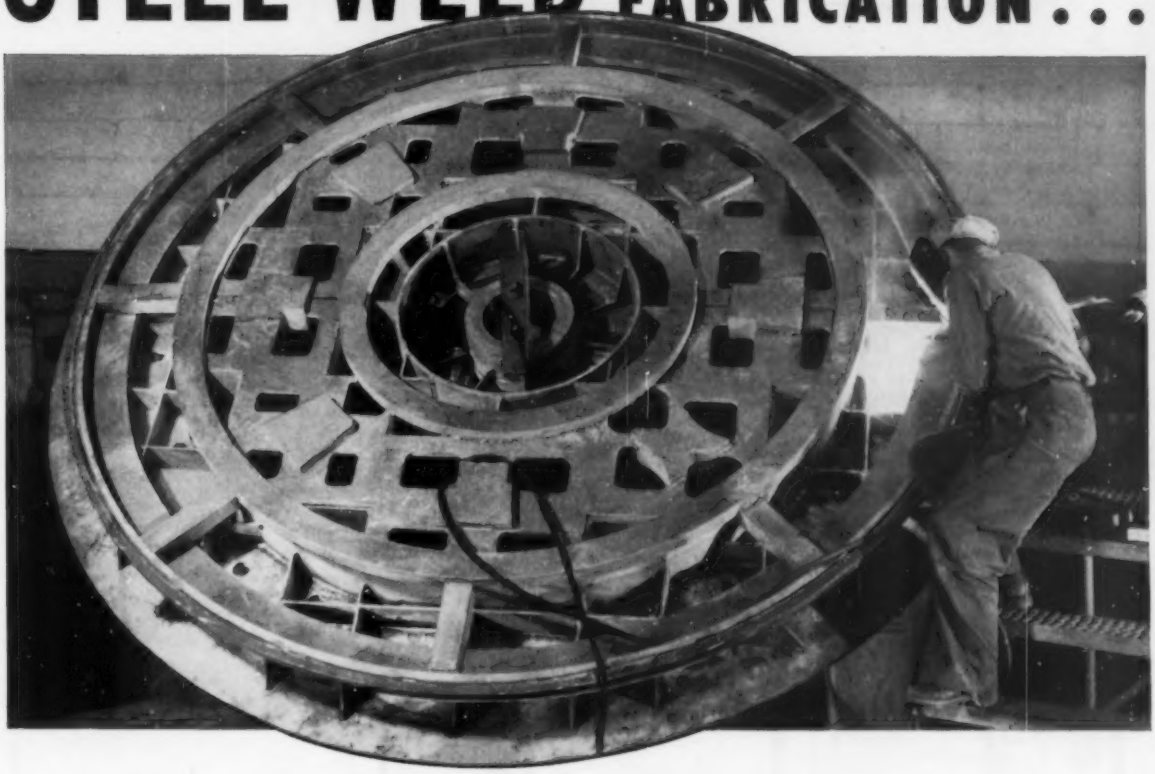


ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

STEEL-WELD FABRICATION . . .



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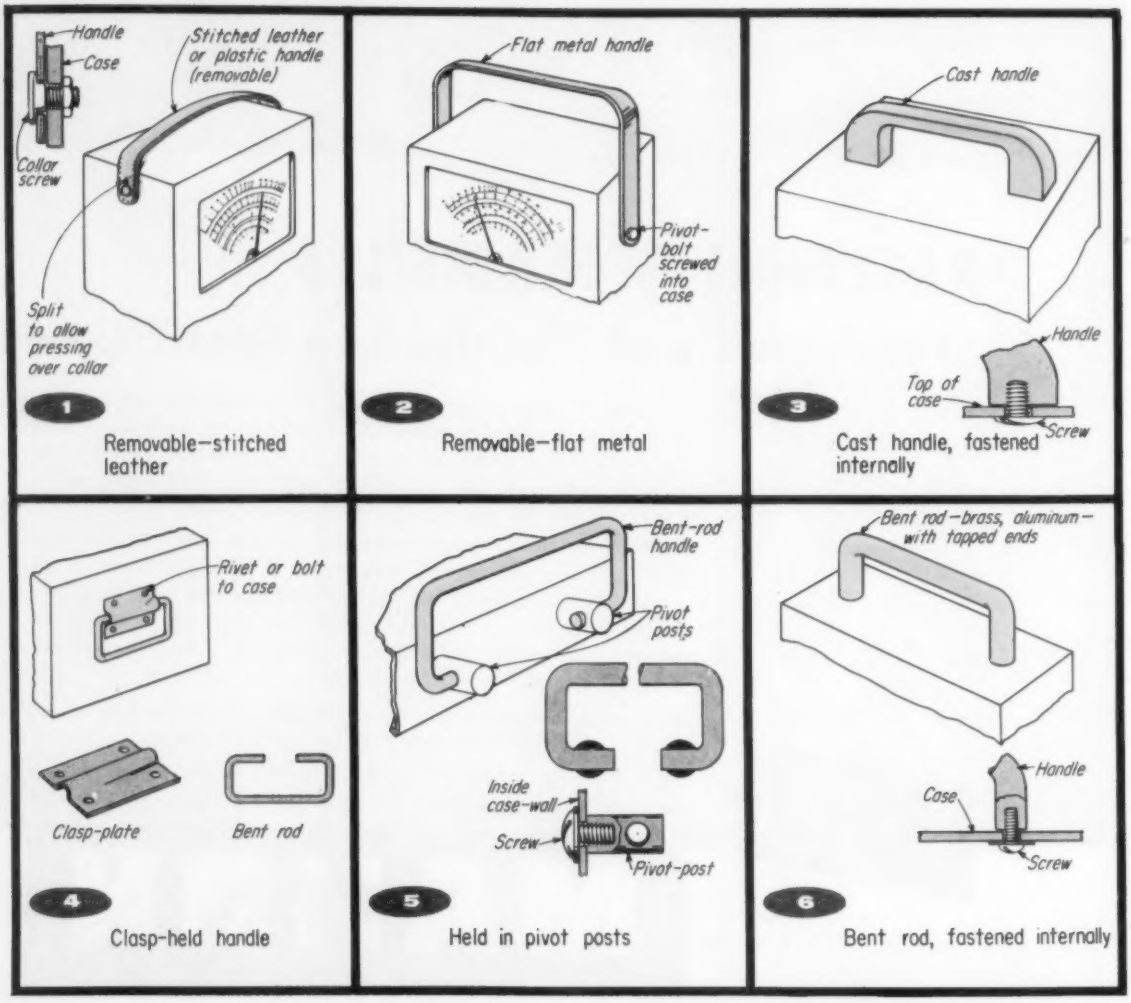
CIRCLE NO. 89 READER SERVICE CARD

13 HANDLES

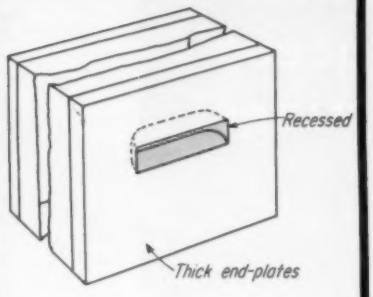
FRANK WILLIAM WOOD JR, design engineer
Vitro Labs, Silver Spring, Md.

Designs here vary from the custom-made, molded-to-fit types to makeshift handles made from standard pipe and flanges.

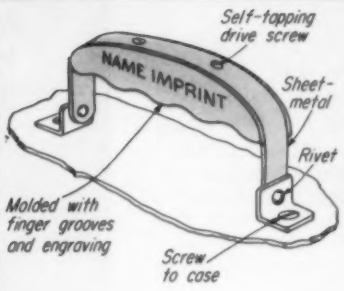
All equipment, from smallest test-meter to the largest console, should provide a good way to carry or move it. Without handles, it will be lifted by its control knobs, terminals, or any other projection that might offer a hand grip—and result in such damage as bent shafts and broken controls. Suitable handles are the answer. And when carefully styled, they improve the appearance of equipment to which they are attached.



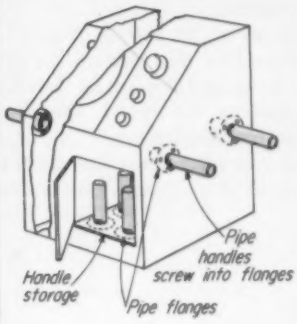
for INSTRUMENTS



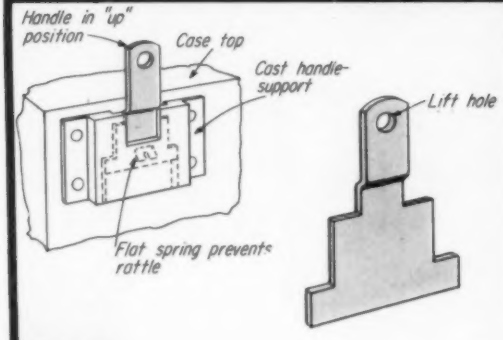
7 "Cast-in" hand recesses



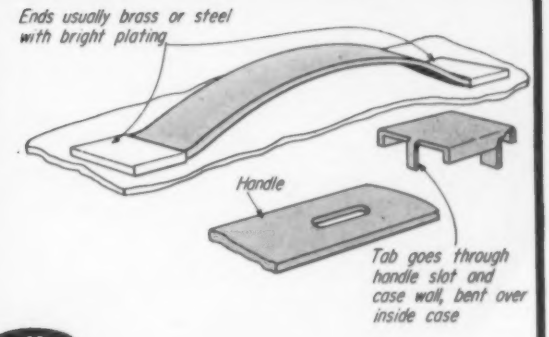
8 Molded handle incorporates company name



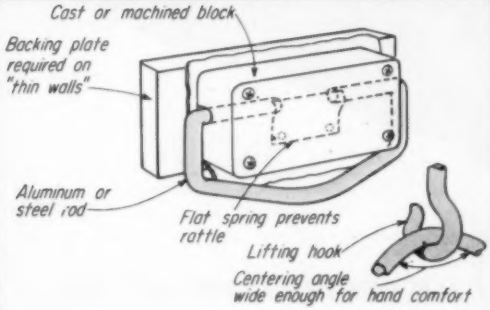
9 Standard pipes and flanges



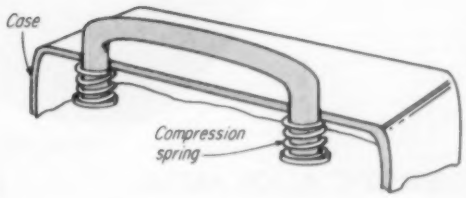
10 Telescoping handle for heavy equipment



11 Vinyl or leather handle with metal end-fasteners


Cast or machined block
Backing plate required on "thin walls"
Aluminum or steel rod
Flat spring prevents rattle
Lifting hook
Centering angle wide enough for hand comfort

12 Heavy-duty mount



13 Spring retraction.

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How do we do it? By *continuous casting*, a process we introduced to this country—a process that eliminates air holes and impurities, leaving a dense, homogeneous casting for better wire-drawing and other fabrication requirements.

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good riddance to "Swiss Cheese" castings!

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worksheet streamlines

BEVEL-GEAR CALCULATIONS

B J MUMKEN, *tool engineer, Sier-Bath Gear & Pump Co, North Bergen, NJ*

The following worksheet neatly gathers together the many mathematical problems that need solving when designing straight bevel-gears. And they are numbered in the correct sequence—no need to hunt "all over the place" as when using formulas in the usual bevel-gear tables. In fact, there are no formulas as such—and, therefore, no need for working with the many Greek symbols found in them.

Instead, the language here is in terms of the actual working operations. For example, space (9) tells you to obtain pitch diameter of the pinion—simply divide the value in space (1) by the value in space (3). And to get root angle for the gear, you are told to subtract the value in space (24) from the value in space (14). Each bracketed number refers you to a value previously filled in.

Just fill in the known values for pinion and gear in the first eight spaces, then work through the sheet, which is based on the Gleason system for 90° straight bevel-gears. Final result (next page) is gear-blank dimensions.

Colored numbers show values obtained in a sample problem worked out by this method.

1	No. of teeth, pinion	40	5	Working depth = $\frac{2.000}{(3)}$	0.200
2	No. of teeth, gear	80	6	Whole depth = $\frac{2.188}{(3)}$ + 0.002 ("D+F")	0.2208
3	Diametral pitch	10	7	Pressure angle	20°
4	Face width	0.750	8	Total backlash	0.003

	PINION (Thick underlining indicates working dimensions)			GEAR	
9	Pitch dia. $\frac{(1)}{(3)}$	4.000	10	Pitch dia. $\frac{(2)}{(3)}$	8.000
11	Tan $\frac{(1)}{(2)}$	0.5000	12	Tan $\frac{(2)}{(1)}$	2.0000
13	Pitch angle (11), in deg.	26° 34'	14	Pitch angle (12)	63° 26'
15	2 X cos (13)	1.7888	16	Cone distance $\frac{(10)}{(15)}$	4.4722
18	Addendum (5) - (17)	0.135	17	Addendum = $\frac{\text{(see table)}}{(3)}$	0.065

Gear Addendum for 1 D.P.
Ratio = (No. of gear teeth)/(No. of pinion teeth)

Ratios From	Ratios To	Addendum, in.	Ratios From	Ratios To	Addendum, in.	Ratios From	Ratios To	Addendum, in.	Ratios From	Ratios To	Addendum, in.
1.00	1.00	0.850	1.15	1.17	0.750	1.41	1.44	0.650	1.99	2.10	0.550
1.00	1.02	0.840	1.17	1.19	0.740	1.44	1.48	0.640	2.10	2.23	0.540
1.02	1.03	0.830	1.19	1.21	0.730	1.48	1.52	0.630	2.23	2.38	0.530
1.03	1.05	0.820	1.21	1.23	0.720	1.52	1.57	0.620	2.38	2.58	0.520
1.05	1.06	0.810	1.23	1.26	0.710	1.57	1.63	0.610	2.58	2.82	0.510
1.06	1.08	0.800	1.26	1.28	0.700	1.63	1.68	0.600	2.82	3.17	0.500
1.08	1.09	0.790	1.28	1.31	0.690	1.68	1.75	0.590	3.17	3.67	0.490
1.09	1.11	0.780	1.31	1.34	0.680	1.75	1.82	0.580	3.67	4.56	0.480
1.11	1.13	0.770	1.34	1.37	0.670	1.82	1.90	0.570	4.56	7.00	0.470
1.13	1.15	0.760	1.37	1.41	0.660	1.90	1.99	0.560	7.00	∝	0.460

19	Dedendum = $\frac{2.188}{(3)}$ - (18)	0.0838	20	Dedendum = $\frac{2.188}{(3)}$ - (17)	0.1538
21	Tan $\frac{(19)}{(16)}$	0.0187	22	Tan $\frac{(20)}{(16)}$	0.0343
23	Ded angle (21)	1° 4'	24	Ded angle (22)	1° 58'
25	Face angle (13) + (24)	28° 32'	26	Face angle (14) + (23)	64° 30'
27	Root angle (13) - (23)	25° 30'	28	Root angle (14) - (24)	61° 28'

(CONTINUED ON PAGE 95)

US RUBBER **PowerGrip** "TIMING" BELTS

It's an open-and-shut case for PowerGrip "Timing" Belts

The Doormasters, Santa Monica, Calif., make door openers for new or existing doors that swing, slide or fold. The entire unit weighs only 20 pounds, hence there is no bulk, and a minimum of support is required. Transmission of power is controlled by U. S. PowerGrip "Timing"® Belt's positive drive. No slippage —no premature closing of door.

U. S. PowerGrip "Timing" Belt permits automatic split-second opening and closing of this unit. Continuous service under the heaviest traffic.

These qualities which led to the adoption of PowerGrip "Timing" Belts by Doormasters, Inc. will make many production machines more efficient. PowerGrip has no metal-to-metal contact, needs no housing or lubrication. Handles speeds up to 16,000 f.p.m. Stock drives are available from U. S. PowerGrip "Timing" Belt Distributors to convert any drives from fractional to hundreds of h.p.

When you think of rubber, think of your "U. S." Distributor.
He's your best on-the-spot source of technical aid,
quick delivery and quality industrial rubber products.

Close-up showing the PowerGrip "Timing" Belt that gives instant non-slip action to the door-opening unit.

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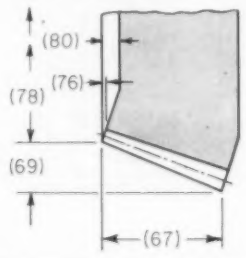
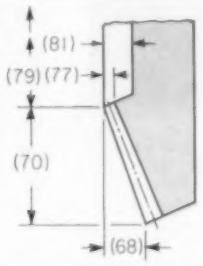
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

BEVEL-GEAR CALCULATIONS *(continued)*

29	cos (13)	0.8944	30	cos (14)	0.4472
31	[2 x (18)] x (29)	0.2414	32	[2 x (17)] x (30)	0.0581
33	OD = (9) + (31)	4.2415	34	OD = (10) + (32)	8.0581
35	(18) x (30)	0.0603	36	(17) x (29)	0.0581
37	Pitch-apex to crown = [0.5 x (10)] - (35)	3.9396	38	Pitch-apex to crown = [0.5 x (9)] - (36)	1.9419
39	Circular pitch = $\frac{3.1416}{(3)}$	0.3141	41	(18) - (17)	0.0700
40	0.5 x (39)	0.1570	42	(41) x tan (7)	0.0254
44	Circular tooth thickness = (39) - (43)	0.1825	43	Circular tooth thickness = (40) - (42)	0.1316
45	$(44)^3$	0.0060	46	$(44)^3$	0.0022
47	$(9)^2$	16.0000	48	$(10)^2$	64.0000
49	6 x (47)	96.0000	50	6 x (48)	384.000
51	$\frac{(45)}{(49)}$	0.00006	52	$\frac{(46)}{(50)}$	0.0000
53	Chordal tooth thickness = (44) - (51) - [0.5 x (8)]	0.181	54	Chordal tooth thickness = (43) - (52) - [0.5 x (8)]	0.1301
55	$(44)^2$ x (29)	0.0298	56	$(43)^2$ x (30)	0.0077
57	4 x (9)	16.0000	58	4 x (10)	32.0000
59	$\frac{(55)}{(57)}$	0.0019	60	$\frac{(56)}{(58)}$	0.0002
61	Chordal addendum (18) ÷ (59)	0.1369	62	Chordal addendum (17) + (60)	0.0652
63	sin (28)	0.8785	64	sin (27)	0.4771
65	cos (28)	0.4776	66	cos (27)	0.8788



PINION



GEAR

67	(4) x (63)	0.6589	68	(4) x (64)	0.3579
69	(4) x (65)	0.3583	70	(4) x (66)	0.6591
71	$\frac{(16) - (4)}{(16)}$	0.8323			
72	(18) x (71)	0.1124	73	(17) x (71)	0.0541
74	(19) x (71)	0.0697	75	(20) x (71)	0.1280
76	[(72) + (74)] x (30)	0.0815	77	[(73) + (75)] x (29)	0.1629
78	(33) - [2 x (69)]	3.5249	79	(34) - [2 x (70)]	6.7399
80	(76) + mfg. std.	0.125	81	(77) + mfg. std.	0.250

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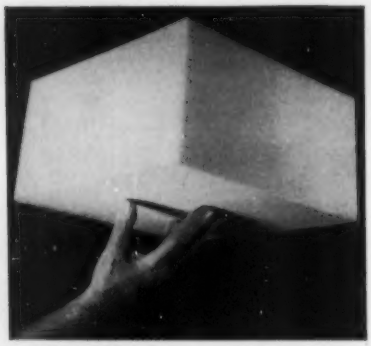
TOUGH! Tear strength up to 8 psi; tensile strength up to 40 psi; may be stretched to 500% of original length without parting.

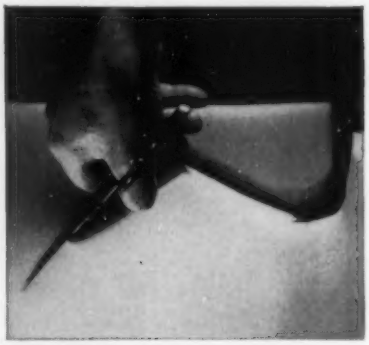
STRONG! Urethane foams have been flexed at 30 cps at 30-80% deflection for 3,000,000 cycles with minimum property loss.

CHEMICALLY STABLE! Urethane foams are unharmed by dilute acids, alkalies, detergents, water or dry cleaning solvents.



LIGHT WEIGHT! At 2 lbs. pcf, properties of urethane foams are superior to other foams weighing twice as much.

SOFT! An entirely new experience in cushioning effect. You will have to *feel* urethane foams to understand the growing preference for these materials in cushioning markets.



VERSATILE! Urethane foams may be sliced, sawed, sewn, stapled, glued, sprayed or foamed in place, die-cut, flocked, laminated, tufted, contour-cut, with standard fabricating equipment.

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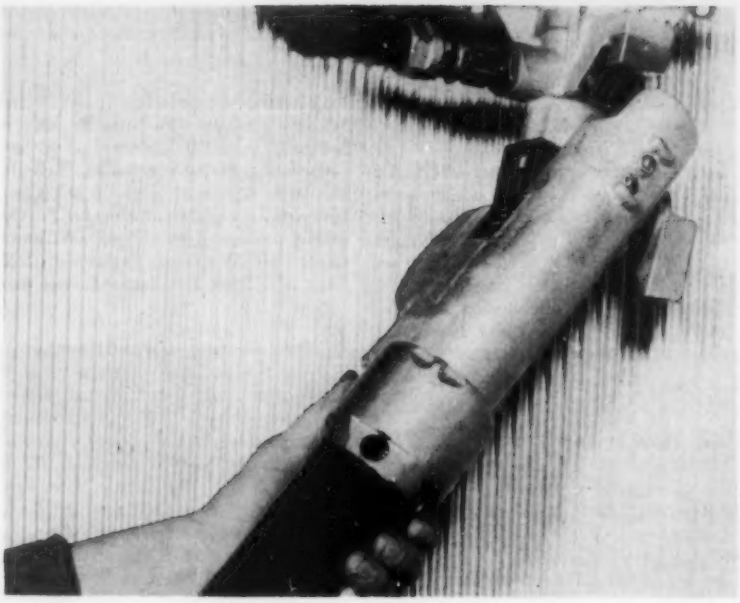


High-pressure connector . . .

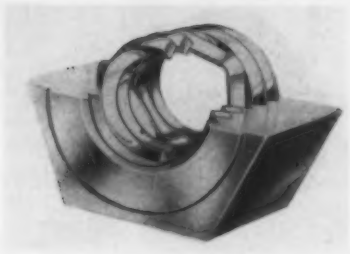
handles air or liquid pressures to 4,000 psi. Burst pressure is around 20,000 psi min. Currently used with compressed air to start aircraft jet engines, hose connector has been released for use by industry. Permits one-hand automatic stoppage of air flow and disconnection of hose. Design is such that malfunction of any moving parts cannot produce jet action that has caused disconnects to whip and endanger personnel. Slight tug on hose causes disconnection and automatic shut-off of air flow. Connector withstands minimum of 5,000 7-ft free-falls onto concrete. When connected, fast flow of air is available. For example, ⅜-in. hose size with 3,000 psi inlet and discharge into atmosphere delivers 650 lb of standard air per min. or 7,500 scfm. Manufactured from corrosion-resistant materials, with neoprene handle to protect swivel joint and hose connection. Cover gives added protection. Offered in variety of sizes and designs to specifications. Standard unit costs $390 for male and female coupling. 30-day delivery. **Besler Corp, 4053 Harlan St., Emeryville, Oakland 8, Calif.**

Circle 300, Reader Service Card

Shock and vibration isolator

originally designed for aircraft and missiles is for use in temperatures to 500 F. Consists of two load-carrying springs, mounted in opposed positions, with built-in damper running axially through them. Varying diameter of spring, wire diameter, assembled length, number of turns of wire, helix angle of spring provide desired load range. All metal parts are interlocked. To customer order. Delivery, about 6 wk. **MB Electronics, Div Textron Electronics Inc, 20 Fitch St, New Haven 11, Conn.**

Circle 301, Reader Service Card



High-strength locknut . . .

incorporates spring-temper stainless steel wire form in aluminum body to meet performance requirements of MIL-C-25027 for 550 F as well as 250 F. Specific configurations shaped into middle winding of coil produce controlled pressure, exerted uniformly and radially, for unvarying torque and locking friction. This eliminates vibration and keeps position constant. May be reused. Offered in coarse series in sizes 4-40, 5-40, 6-32, 8-32, 10-24, ¼-20, $\frac{5}{16}$-18 and ⅜-16; in fine series, in sizes 6-40, 10-32, ¼-28, $\frac{5}{16}$-24 and ⅜-24. 4-40 nut is immediately available. May be purchased with body made from material other than aluminum, if specified. In quantities of 1,000 to 4,999, locknuts are 0.051¢ each; 5,000 or more, 0.043¢ each. **Waltham Precision Instrument Co, 221 Crescent St, Waltham 54, Mass.**

Circle 302, Reader Service Card

Pressure-controlled valve . . .

can perform such functions in a hydraulic circuit as relief, sequencing, unloading, reducing and counterbalancing. Meehanite castings are said to have demonstrated bursting pressures of not less than four times max rating. Meets all JIC requirements and available in pipe and sub-plate mountings, with and without check, direct or pilot operated. With flow rating of 15 fps, small-size valve is rated at 9 gpm with ½ in. max pipe size; medium has capacity of 27 gpm with 1 in. max pipe size; large, 55 gpm with 1½ in. max pipe size. Priced from $30 to $120. Small valves will be available from stock in November; medium, from stock in October; large, from stock in December. **Rivett, Inc, Brighton 35, Boston.**

Circle 303, Reader Service Card

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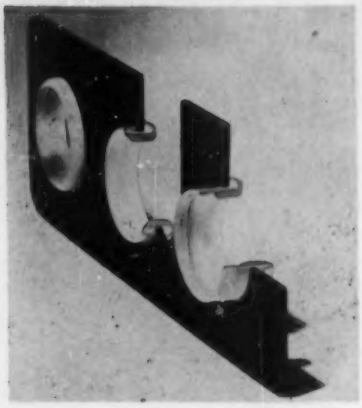


One-piece nylon grommet . . .

fits snugly and cannot shake loose or pop out when installed through aperture provided (see cutaway) and flanged over by common drill, arbor press, or hand pressure mechanism. Hoop stresses induced in flange hold grommet in place permanently. Used in temperature range of —65 to 300 F. Stocking is simplified because each size from $\frac{1}{8}$ to 2$\frac{1}{2}$ in. dia fits sheet gages from 0.025 to 0.250 in. in four basic lengths. Made from Zytel 103 nylon. In lots of 10,000, prices range from 9.5¢ each for $\frac{1}{8}$-in. dia to 13.4¢ each for 2$\frac{1}{2}$-in. dia. Free sample cards and/or samples in any size are available on request. Delivery from stock. **Western Sky Industries, 21301 Cloud Way, Hayward, Calif.**

Circle 304, Reader Service Card

Centrifugal air blower . . .

operates at 3000 rpm using 115-v, single-phase, 60 or 50 cps or 230-v, single phase, 60 or 50 cps current. Delivers 106 cfm of air at 1 in. wg static pressure. Weighs 6 lb. Dimensions 6 x 6 x 8$\frac{1}{2}$ in. **American-Standard Industrial Div, Detroit 32.**

Circle 305, Reader Service Card

All-metal bellows shaft seal

operates at pressures to 1,000 psi, speeds to 36,000 rpm and temperatures from —400 to 1,000 F. Resists most corrosive bases and acids, both liquids and gases, and seals hazardous fluids. Available in sizes up to 7 in. shaft dia. **Turbocraft Inc, 492 E Union St, Pasadena, Calif.**

Circle 306, Reader Service Card

Combination filter-solenoid

has total over-all length of 2$\frac{7}{8}$ in. In 6 or 12 v models with $\frac{1}{4}$-in. female pipe inlet and $\frac{1}{4}$-in. male pipe outlet. Complete unit weighs 8 oz, for installations using up to 4 gph of liquid fuel. Lists at $16. **Beam Products Mfg Co, Los Angeles 65.**

Circle 307, Reader Service Card

Complex extruded Teflon . . .

shapes for electrical, electronic and mechanical applications are made in continuous form from segmented dies, to customer specifications, and later cut to required lengths (to 0.030 in. min). Shapes have continuous service temperature of 482 F. Max thickness at any cross section is about 0.100 in. **Pennsylvania Fluorocarbon Co Inc, Philadelphia.**

Circle 308, Reader Service Card

Subminiature duplex clutch . . .

has total torque output of 20 in.-oz at 3.5 w and zero backlash. Weighs 2.4 oz. Response time is 8 millisec. Can be supplied for 6 to 115 v dc. Size 8 clutches are available in reverse or direct-acting types and in any combination of brake and/or clutch actions. **Orbit Instrument Corp, 131 Eileen Way, Syosset, NY.**

Circle 309, Reader Service Card

Air hand-control valve . . .

is cam-actuated and said to respond instantly to slightest movement. Compensating aluminum valve weighs 1$\frac{1}{2}$ lb. **Midland-Ross Corp, Owosso Div, Owosso, Mich.**

Circle 310, Reader Service Card

High-temperature potentiometer . . .

gives electrical indication of mechanical position when used with hydraulic actuators, pneumatic valves and linkage components. Model 113 linear motion potentiometer operates in —65 to 500 F with high-level ac or dc signal, requiring no amplification for use in recording, control and telemetering circuits. Incorporates metal-to-metal bond resistance element termination. Travel range is 0-1.31 in. Power rating is 4 w at 40 F. Available in resistances of 1000, 2000, 5000, 10,000 and 20,000 ohm. Resolution, from 0.001,3 to 0.003,5 in. Designed to meet or exceed most government specifications. Price depends on various optional features incorporated in unit. Delivery, 10 wk. **Bourns Inc, PO Box 2112, Riverside, Calif.**

Circle 311, Reader Service Card

Synthetic grease . . .

is resistant to gasoline, solvents and water and to wipe-off or throw-off in valve applications. Inherent stability from —20 F to 300 F. Has low evaporation rate, covering metal with film that acts as seal against humid and salt conditions. Available in 1 and 5-lb cans and drums up to 400 lb. **Lehigh Chemical Co, Industrial Lubricants Div, Chestertown, Md.**

Circle 312, Reader Service Card

Semi-flexible connector . . .

is for use with semi-flexible aluminum sheathed coaxial cable. No special tools or dies are necessary to prepare cable. $\frac{1}{2}$-in. connector slips on cable and is secured with standard wrenches. **Spec Electronics, Dept H, PO Box 64314, Los Angeles 64.**

Circle 313, Reader Service Card

Separator-regulator-lubricator

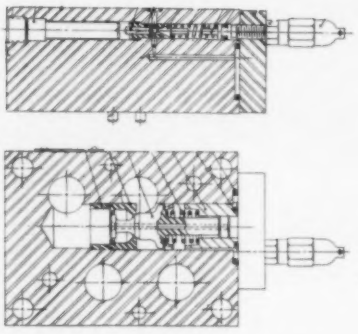
are combined in this miniature unit to bring dry, regulated, lubricated air to compressed-air operated equipment. Fits JIC standards. Combination (9 x 6 in.) is fully automatic. Available in $\frac{1}{4}$ in. NPT. Operating pressure, 5 to 250 psi. **Wilkerson Corp, 1656 W Girard, Englewood, Colo.**

Circle 314, Reader Service Card

Resistance pressure detector . . .

measures gas, fluid or vapor pressure in combination with Omnigard temperature monitoring systems and converts directly to electrical resistance. Covers pressure ranges to 3000 psi. Operates in 32 to 150 F with min error. 2$\frac{7}{8}$ x 2$\frac{1}{8}$ in. long. **Thomas A Edison Industries, McGraw-Edison Co, West Orange, NJ.**

Circle 315, Reader Service Card



Pipe-less relief valve . . .

is one of a series of hydraulic pilot-operated pressure relief valves, which are installed in circuit by being sandwiched between $\frac{3}{4}$-in. gasket-mounted, four-way valve and sub-plate or manifold. Stacking of circuit components eliminates interconnecting pipes and reduces size of valve panel required. Savings up to 50% are claimed over cost of mounting and piping relief valves in conventional, separate manner. **Double A Products Co, Sub of Brown & Sharpe Mfg Co, Manchester, Mich.**

Circle 316, Reader Service Card

Silicon power rectifier . . .

is fused alloy device for operation at 1 to 15 amp, single phase, half-wave average. Operates —85 to 347 F. Mounted on

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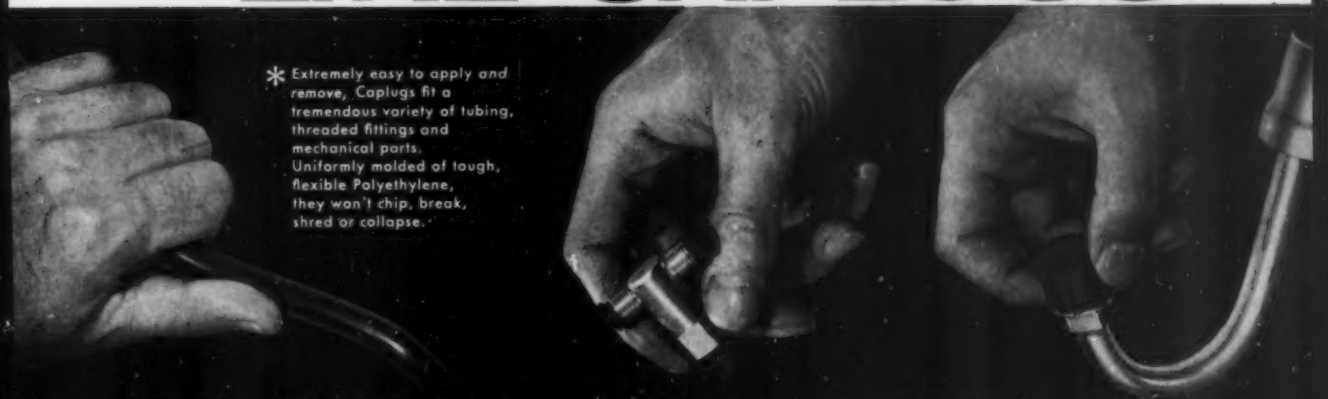

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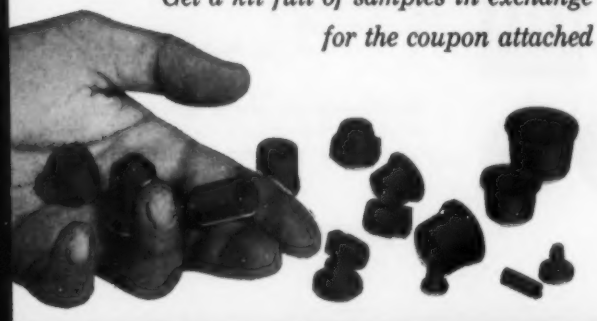

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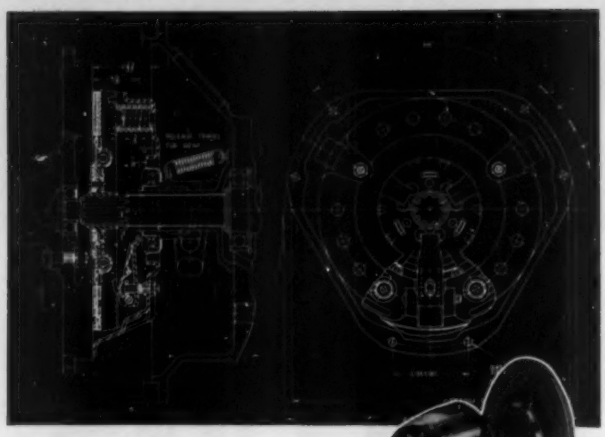

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

209 Catherine St., Rockford, Ill., U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

ROCKFORD B-W BORG-WARNER

CLUTCHES

$\frac{7}{16}$-in. hexagon stud-type case with glass-to-metal seal cap. Max height is $1\frac{3}{16}$ in. Syntron Co, 240 Lexington Ave, Homer City, Penna.

Circle 317, Reader Service Card

4-way air valve . . .

operates on bleed principle to allow adjustment of forward and reverse cylinder stroke. Operates on as little as 1 psi. Cleveland Pneumatic Industries, 64 Old Orchard, Skokie, Ill.

Circle 318, Reader Service Card

Subminiature elapsed time . . .

indicator is available with various dials, for 115 v, 60 cps. Reads to 9999.9 in $\frac{1}{10}$-hr increments and draws less than 3 w. A W Haydon Co, Waterbury, Conn.

Circle 319, Reader Service Card

10-key keyboard . . .

accepts data serially for recording or control purposes and can be used with any electronic device able to supply required voltage. Weighs 12 oz; measures $3\frac{3}{4}$ x $1\frac{1}{2}$ x $4\frac{1}{4}$ in. Victor Adding Machine Co, 3900 N Rockwell, Chicago 18.

Circle 320, Reader Service Card

Elapsed time counter . . .

provides continuous and reverse operation for 24-hr periods in minutes and hours, graduated in $\frac{1}{10}$-min increments. Operates to 300 rpm, although normal speed is $\frac{1}{10}$ rpm at input shaft. Bowmar Instrument Corp, 8000 Bluffton Rd, Fort Wayne, Ind.

Circle 321, Reader Service Card

Electric cartridge heater . . .

operates at 750 F max temperature, 60 w per sq in., and is sheathed in brass. Can be used singly or grouped. Ranges in size from $2\frac{1}{2}$ to 12 in. long x $\frac{1}{4}$ to $1\frac{1}{4}$ in. dia. Rated 200 to 2800 w. General Electric Co, Schenectady 5.

Circle 322, Reader Service Card

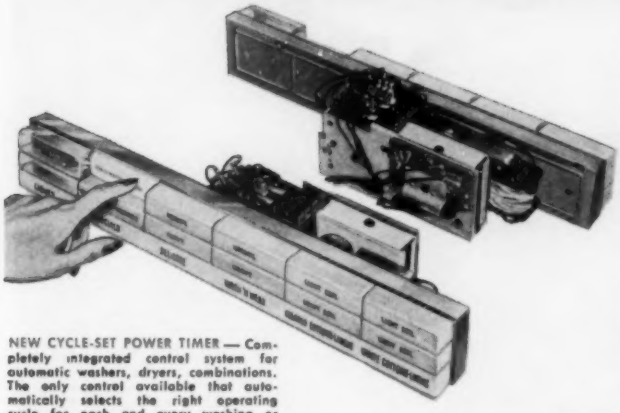
Multipurpose dual connectors

for use with binding posts mounted on $\frac{3}{4}$-in. centers are offered shielded and

(Continued on page 103)

Every appliance made today can be controlled just a little bit better with...

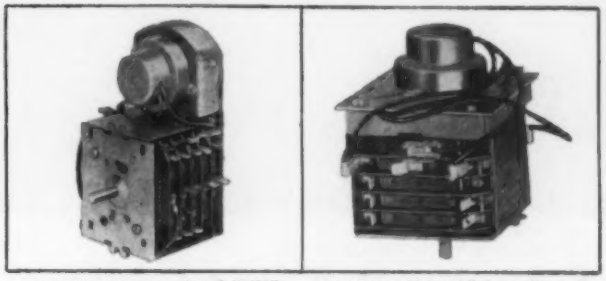
CC CONTROLS



NEW CYCLE-SET POWER TIMER — Completely integrated control system for automatic washers, dryers, combinations. The only control available that automatically selects the right operating cycle for each and every washing or drying situation.

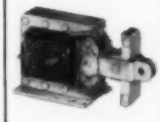
Individual components or completely integrated systems. Whichever you choose, you can be sure of this: Controls Company products are function-mated to the appliances they control. Field records show this results in extra value that helps sell the end-product . . . *and keep it sold!*

Shown here are some of the CC controls now helping to make many appliance lines just a little bit better than competition. Write for facts about these and other CC controls.



LATERAL TIMERS — Just 2-17/32" deep. For washers, dryers, combinations dishwashers, other automatic equipment.

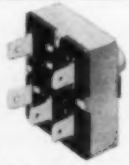
TANDEM TIMERS — Drive mechanism to rear of switch case for "tight-squeeze" installation in automatic equipment.



SOLENOIDS — Exclusive double T plunger means more pull for more applications. Four types, twelve models.

SNAPAC SWITCHES —750 Series (shown) for limit, safety interlocking, door and control switch needs.

PRESSURE SWITCHES — Single and multi-level pressure. Designed to control liquid levels.



ROTARY SWITCHES — Compact 777 Series (shown) ideal for appliances, vending machines.

SYNCHRONOUS MOTORS—offer eleven speeds, three shaft types, two lube systems.

INTERVAL TIMERS —Type 105 (shown) for preset appliance time control.

SOLENOID OPERATED SWITCHES — Type 12270 makes, breaks two circuits simultaneously.

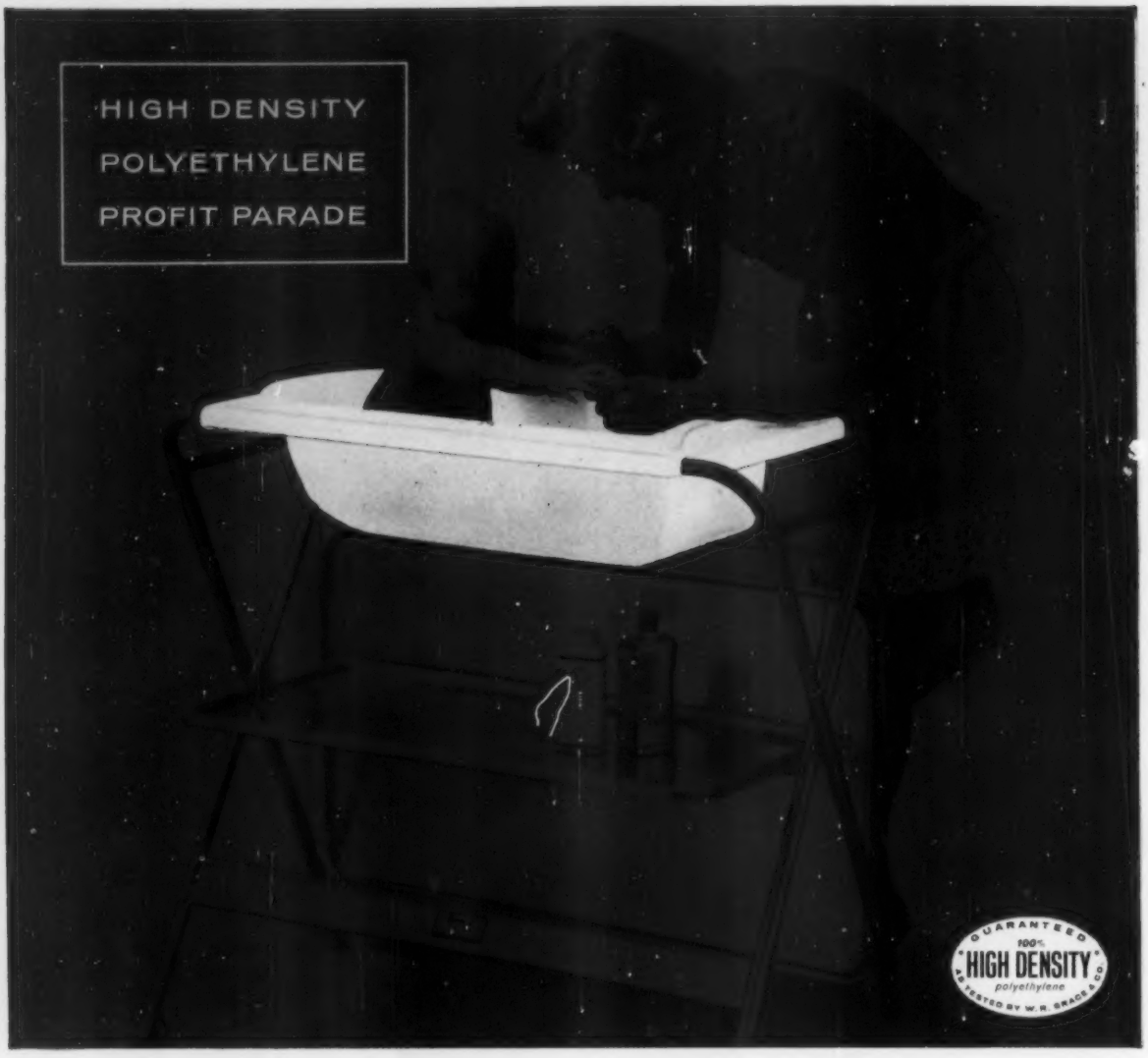
Creative Controls for Industry

CONTROLS COMPANY OF AMERICA

9563 Soreng Avenue • SCHILLER PARK, ILL.

COOKSVILLE, Ontario • NIJMEGEN, Holland

CIRCLE NO. 101 READER SERVICE CARD 101



Exclusive Selling Advantages Offered in Lifetime Tub

Products in many different fields are gaining an edge over competition by utilizing the benefits of Grex high density polyethylene. The "Lifetime Tub" by Baby Bathinette Corporation is an example that really holds water.

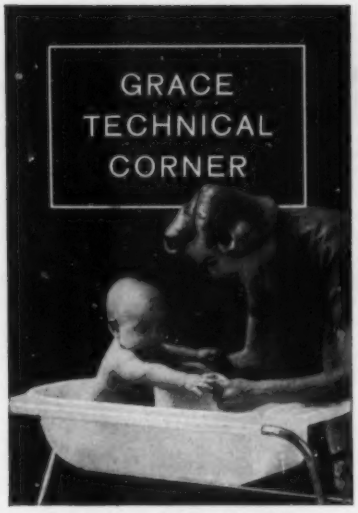
This well-known manufacturer chose Grex to make a tub that would outlast competitive models since this is a tough plastic that is virtually indestructible. They used its molding characteristics to obtain a soft, pleasant, easy-to-clean texture. They took advantage of its strength and rigidity to make the tub light in weight for greater ease of carrying.

This new Grace plastic offers a unique combination of properties to help you create unique selling advantages. It takes a beating without chipping, cracking or breaking. It can be molded in any color and decorated. It resists the elements and most corrosive chemicals. And it is the only thermoplastic that takes boiling or freezing without losing its shape or strength.

If you need an idea of how to gain an edge over competition by using high density polyethylene be sure to call in the experts. Grace has the production facilities, technical service and experience to help put your product in the Grex profit parade. We're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION CLIFTON, NEW JERSEY



Grex answers design and molding problems on extra-large piece.

Don't let size limit your thinking when designing or molding with Grex high density polyethylene. The "Lifetime Tub" shown here is 30½" x 6½" x 19"—one of the largest pieces so far injection molded with this Grace plastic. Some of the technical thinking that went into this job may give you an idea of how to get the most from Grex.

Cost a design factor. Production of a piece as large as this tub invariably presents a cost problem. Taking advantage of the way Grex performs in thin wall sections, the designers were able to keep the amount of resin per tub to a minimum and permit economical cycle times. Use of thin walls, however, called for a design that would not only take care of the weight of baby and water but also provide for satisfactory suspension of the tub in its metal frame. Reverse curves solved both problems and minimized use of ribs and fillets to avoid heavy sections, sinks and depressions.

Mold surface. Depending on mold surface, Grex takes any finish ranging from high gloss to matte. In this case, it provided a smooth, pleasant texture—essential to protect baby and make cleaning easy—through the use of a highly polished chrome-plated mold.

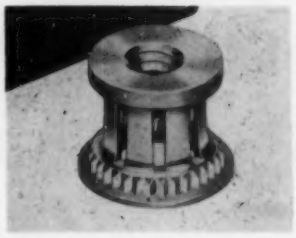
Molding technique. Production of the tub involved a 3-pound shot of Grex, a large mold cavity and thin wall sections. Under these conditions, multigating was chosen over normal gating. With four gates the cavity was filled faster and strain reduced.

What are your problems? If you have a job in mind for high density polyethylene count on Grace for help. Now's the time to call, wire or write:

Technical Service Department,
Polymer Chemicals Division,
W. R. Grace & Co., Clifton, N. J.

insulated, or insulated, with gold-plated conducting surfaces, color-coded captive thumbnuts and protectively recessed twin banana plugs. Shielded unit, $4.50; insulated plug, $2.50. **Superior Electric Co, Dept DLP, Bristol, Conn.**

Circle 323, Reader Service Card



Clinch-type fastener . . .
is for use with honeycomb panels having fibrous cover sheets. Made of carbon steel and stainless for range of panel thicknesses. Installed by standard pneumatic gun. **Delron Co Inc, 5224 Southern Ave, South Gate, Calif.**

Circle 324, Reader Service Card

Polyethylene repels dust . . .
in two compounds for injection molded applications. Materials minimize dust attraction because they do not retain electrical charge. DPD-7366 is based on polyethylene copolymer introduced recently, offering such properties as low-temperature toughness and improved rigidity. DNDA-0401 is a high-flow, general-purpose antidust material with slightly less rigidity than its companion compound. Properties for both compounds include tensile strengths of 1,600 and 1,420 psi; elongation of 210 and 134%; yield strength of 1,500 and 1,320 psi, respectively. Secant modulus at 73.4 F is 40,000 psi for the DPD-7366 compound; 29,000 psi for the DNDA-0401 material. Priced, in quantities of 20,000 lb or more, at 36 and 35¢ per lb. From stock. **Union Carbide Plastics Co, Div of Union Carbide Corp, 420 Lexington Ave, New York 17.**

Circle 325, Reader Service Card

Pressure control valves . . .
hold to within $\frac{1}{10}$-lb despite varying inlet pressures. Adapts to variety of sizes and pressure settings. Operates from 0 to 300 psi; functions —65 F to 480 F. Said to be usable with most gases or fluids. Weighs 1 lb 7 oz. **Besler Corp, 4053 Harlan St, Emeryville, Oakland 8, Calif.**

Circle 326, Reader Service Card

Silicon printed circuit . . .
rectifier assemblies mount in any desired configuration and are usable on boards to 302 F. Available for single and 3-phase power supply applications in half-wave,

(Continued on page 106)

'DIAMOND H'
SERIES W

General Purpose Relays

MEASURE ONLY:
1⅛" x 1⅛" x 1⅛"

BUT CARRY:
to 25 A. resistive at 115-230 V., A. C.; 1 h.p., 125 V., 2 h.p., 250 V., A.C.; D. C. and other higher ratings on request.

CONTACTS:
DPDT, Double Break-Double Make (Form Z). Special arrangements and sequence on request.

MOUNTINGS:
Socket, panel and sidewall arrangements standard; others to meet special needs.

"Diamond H" engineers are prepared to work out variations of these rugged, dependable relays to meet your specific requirements in such applications as **automation controls, appliances and air conditioning equipment,** or what you will. Just ask.

THE
HART
MANUFACTURING
COMPANY
206 Bartholomew Avenue
Hartford, Conn.
Phone Jackson 5-3491

News about COATINGS FOR METALS
from Metal & Thermit Corporation

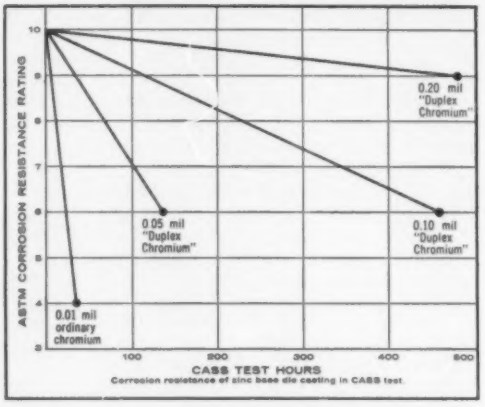
How to get the optimum protection of bright chromium plating

There are three requisites to increasing corrosion protection from chromium plating. (1) The deposit must be sufficiently thick. (2) There should be a crack-free chromium base topped by a special, finely cracked chromium deposit. (3) The plate should be more uniformly distributed over the part, so that recessed areas, too, are assured at least 0.03 mils minimum chromium thickness.

All of these requirements are easily met through UNICHROME SRHS® CHROMIUM plating processes. Work done for the automotive industry, long plagued by corrosion of brightwork in outdoors exposure, provides a good case in point.

AN ANSWER TO OUTDOOR CORROSION

Note the results in the chart at right. In all cases, the thickness of undercoats was kept constant. Only the chromium plate was varied... from ordinary to "Duplex", and progressively thicker. M&T "Duplex Chromium" calls for first using Unichrome Crack-Free Chromium and its ability to throw into recesses and give a more uniform and fracture-free plate. This is followed by another deposit of Unichrome SRHS Chromium, with its *controlled* cracking. With increasing thickness, the protection increased tremendously. Durability as determined by rigorous, accelerated corrosion testing techniques was multiplied as much as *20 times*.



Zinc die cast specimens, all plated with 0.75 mil copper and 0.75 mil nickel prior to chromium lasted as shown above in the severe CASS test (Copper accelerated acetic acid salt spray). Ordinary chromium fared poorly. Optimum protection was approached by using Crack-Free Chromium and increasing the deposit thickness.

Despite severe service conditions, automotive brightwork can stay bright now, due to the additional corrosion protection that M&T "Duplex Chromium" provides.

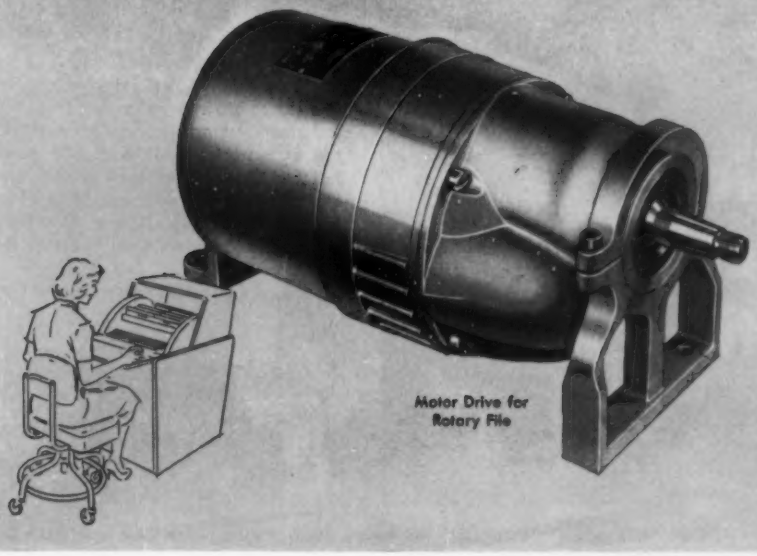
WIDELY USEFUL FINISH

While the above case concerns itself specifically with an automotive problem, it indicates what thicker chromium in general, and crack-free chromium in particular can do for other design problems involving corrosion and wear. This plate blocks infiltration of corrosives to underlying metal.

Technical Papers giving full details on the advantages of thicker chromium deposits are available for the asking. Write METAL & THERMIT CORPORATION, Rahway, New Jersey.

METAL & THERMIT
CORPORATION

Repeated Starts, Stops, Reversals Needed For This Motor Drive . . .



Motor Drive for Rotary File

What Are Your Motor Requirements?

A business machine manufacturer came to us with this problem: he wanted a motor developed that would provide push-button operation for a rotary file in which thousands of records could be mounted on a large wheel.

Requirements for the motor were that it must be capable of repeated starts, stops and reversals . . . that it incorporate a special gear train that would assure quiet operation through many thousand hours of service . . . that it provide for quick and accurate stopping (accomplished with a magnetic brake).

Your motor requirements may be entirely different. But whatever they are, we will bring to the problem 44 years of widely diversified experience in the field of small motors to help you obtain the results you desire.

THE LAMB ELECTRIC COMPANY · KENT, OHIO
A Division of American Machine and Metals, Inc.
In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

Lamb Electric
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

Actuator motor for automatic supermarket scale. Frame 2⅞ x 1⅜.

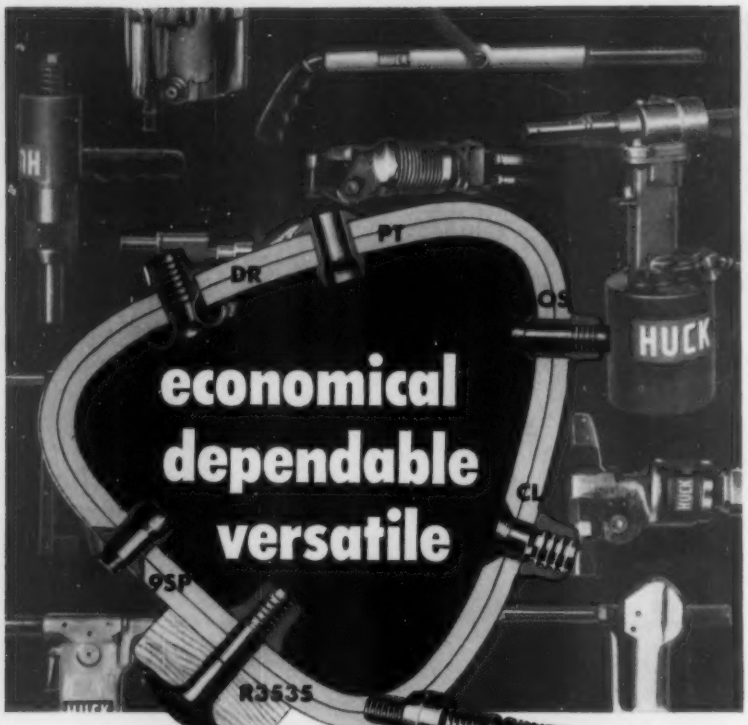
⅙ Horsepower motor with two-stage fan—the standard for high performance domestic canister-type cleaners.

Four-pole split phase motor with resilient cradle base for business machines. Frame 4½ x 2¼.

110 Volt DC servo motor designed with maximum torque-to-inertia ratio for tape reel drive on computers. Frame 5¼ x 6.

Write for your copy...
8-page folder describes these and other Lamb Electric motors.

CIRCLE NO. 105 READER SERVICE CARD



fasteners by **HUCK**

CL
High strength, shear and tension.

9SP
Low cost blind fastener.

PT
Grommet type blind fastener.

DR
Broad grip, broad bearing.

OS
High strength blind fastener.

R3535
High strength, broad bearing.

Nearly two thirds of any fastening operation cost is in labor.

The Huck fastening system is designed for time saving, uniform installation with greater fastener dependability.

Huck pneumatic, hydraulic or manual installation tools are compact, light and easy to operate. Even with unskilled operators, installation rates of 25 to 30 fasteners per minute are normal.

There is a Huck fastener for every need—high shear or tension, self sealing, broad bearing, hole broaching, hollow or pin retaining, blind or regular style — aluminum, steel or high temperature metals—headstyles, diameters and lengths to fit your job.

Write for Huck's Fastener Catalog. Our experienced fastener engineers will gladly help you.

HUCK MANUFACTURING COMPANY

2480 Bellevue Avenue • Detroit 7, Michigan • Phone WA 3-4500

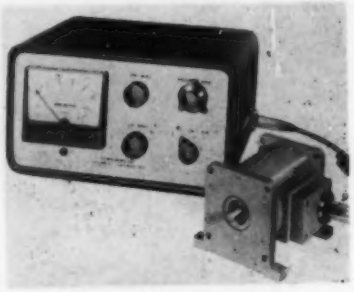
double, center tap and bridge circuits. Basic ratings are up to 3 amp dc output and 800 v in single-phase assembly; 4.5 amp dc in three-phase assembly. **International Telephone and Telegraph Corp, Components Div, Clifton, NJ.**

Circle 327, Reader Service Card

Size 18 servo motor . . .

has been added to 115 v, 60 cps line. Weighs 15 oz, with encapsulated windings and stainless housing. Requires power input of 9 w per phase with 0.64 power factor. Offers no-load speed of 3200 rpm. Operates continuously at stall to unit temperatures of 392 F. **Helipot Div, Beckman Instruments Inc, 2500 Fullerton Rd, Fullerton, Calif.**

Circle 328, Reader Service Card



Adjustable full scale torque . . .

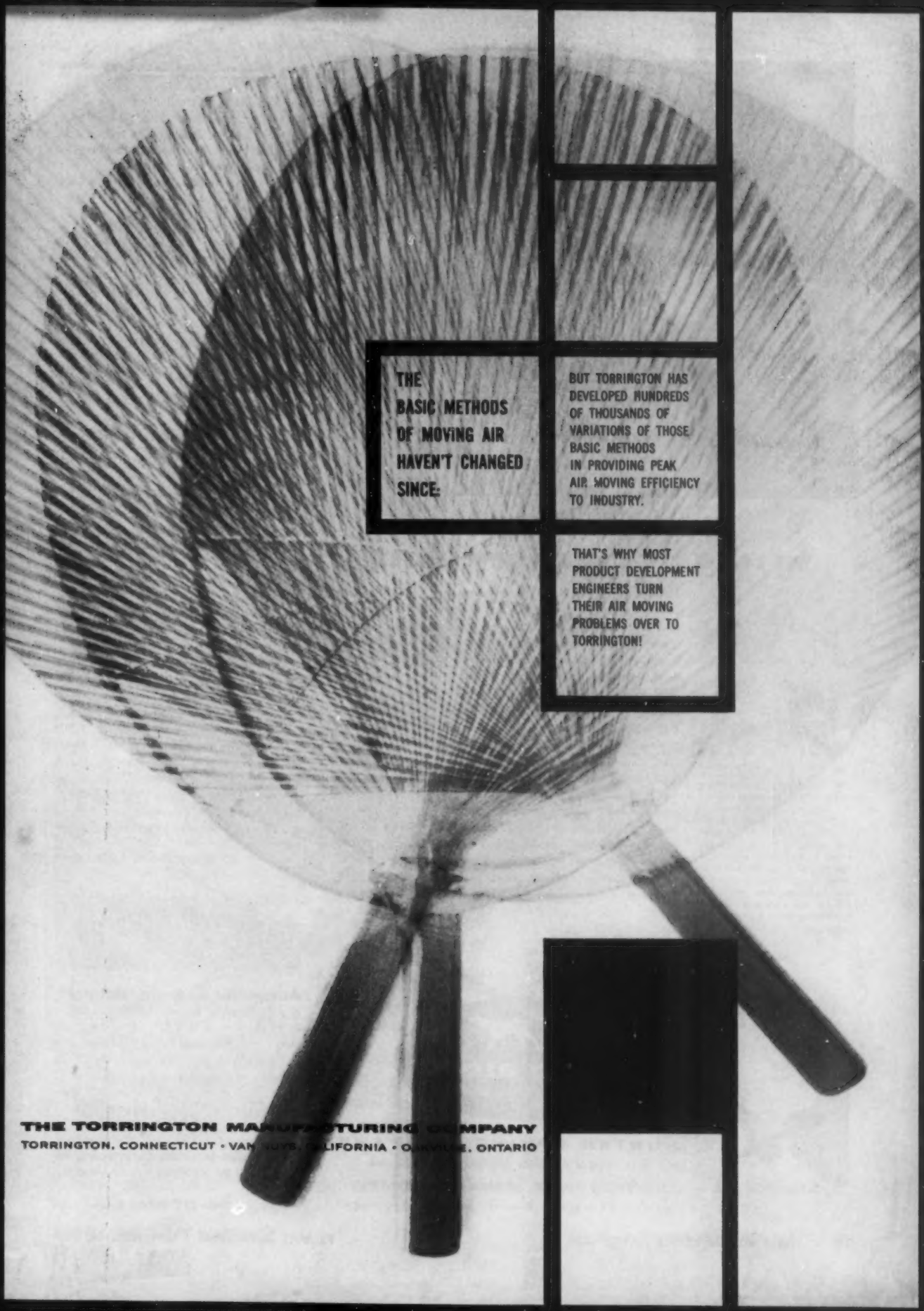
is provided by torquemeter within range 50 to 100% of sensor maximum torque. Permits smaller torque increments to be observed. Detects dynamic torque transmitted by shafts rotating at speeds to 24,000 rpm without brush contact with rotating elements. Torque is continuously displayed at indicator with accuracy within 2% of selected full-scale reading. Change in full-scale reading is accomplished at indicator panel without additional calibration. Interchangeable sensors have max torque ratings from 10 to 400 in.-lb and are provided with means for both mounting to base and for overhung mountings from ends. Electrical system requires neither vacuum tubes nor external voltage regulation to achieve portability. Price for torquemeter, including indicator and sensor, $845; with sensors having max torque rating over 150 lb, slightly higher. Additional sensors, depending on torque rating, average $390. Delivery, 4 wk. **Rotiform Co, 1509 Colorado Ave, Santa Monica, Calif.**

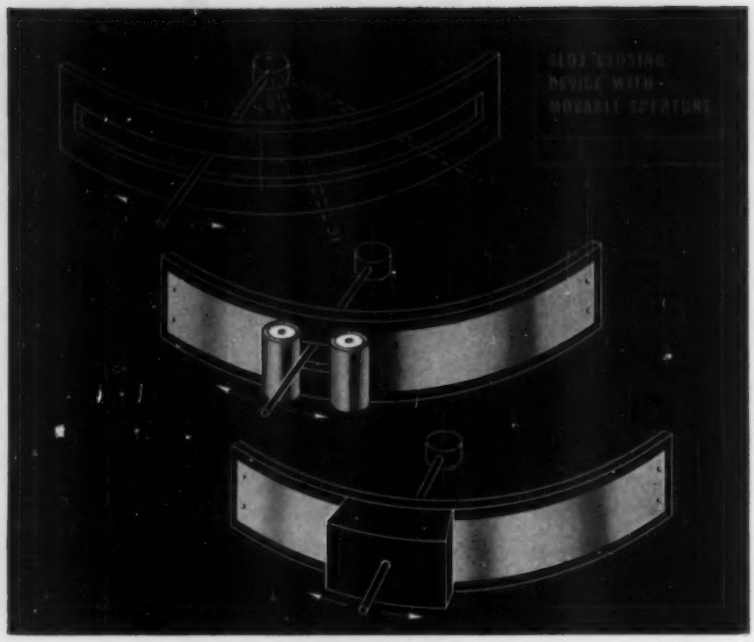
Circle 329, Reader Service Card

Force ring transducer . . .

combines loading accuracy of proving ring and motion measuring accuracy of displacement transducer. Proving ring picks up loading magnitude and translates into

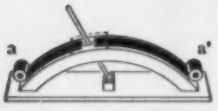
(continued on page 108)

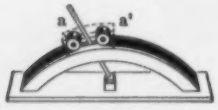

THE BASIC METHODS OF MOVING AIR HAVEN'T CHANGED SINCE:
BUT TORRINGTON HAS DEVELOPED HUNDREDS OF THOUSANDS OF VARIATIONS OF THOSE BASIC METHODS IN PROVIDING PEAK AIR MOVING EFFICIENCY TO INDUSTRY.
THAT'S WHY MOST PRODUCT DEVELOPMENT ENGINEERS TURN THEIR AIR MOVING PROBLEMS OVER TO TORRINGTON!
THE TORRINGTON MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT · VAN NUYS, CALIFORNIA · ORILLIA, ONTARIO



Simplify Slot Closure

WITH NEG'ATOR® SPRINGS





TWO METHODS of mounting NEG'ATORS for slot closure. Above, the free ends of the balanced NEG'ATORS are attached to the traversing unit (the movable aperture) and the NEG'ATOR coils (a and a') are mounted, out of the way, on a stationary section of the equipment. Below, the free ends are fixed and the coils are mounted on the moving member. Where space is available, the mounting below is preferred because of minimized friction.

Paired, equal-force NEG'ATOR Springs, forming flat bands as they uncoil, make an effective cover for slots and provide a movable access through the slot as shown above. This is just another example of how alert engineers have utilized *constant-force* NEG'ATOR Springs to solve unusual design problems.

Slot closure devices incorporating NEG'ATOR Springs are inexpensive, compact and foolproof in operation. Each design utilizes two NEG'ATOR Springs to mask the openings created on either side of the movable aperture. One NEG'ATOR extends as the other re-coils and their equal and unchanging forces counterbalance each other.

Typical application possibilities for NEG'ATOR-equipped slot closure devices include: grinding machine shields, bomber gun turrets, machine tool ways, splash guards, dust enclosures, safety shields, electrical enclosures, and sound baffles—just to mention a few. Can NEG'ATOR Springs solve your particular design problem? Find out more about this versatile component —the first *constant-force* spring—by requesting Bulletin 310N.

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

5 Spring Avenue, Lansdale, Pennsylvania

SPRINGS · STAMPINGS · QUALITY CONTROL EQUIPMENT

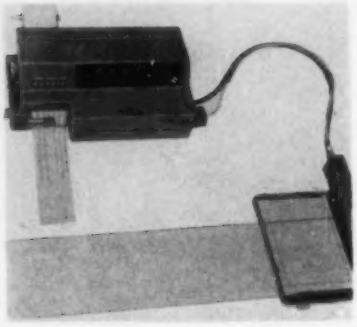
ring deflection. Transducer measures ring deflection and converts into electrical output that can be indicated or recorded in terms of load. **Morehouse Machine Co, 1742 Sixth Ave, York, Penna.**

Circle 330, Reader Service Card

Insulated shaft coupling . . .

consists of two aluminum flanges with projecting segments that engage each other through nonmetallic nonconducting insert that carries load in compression, and absorbs shock and torsional vibration. Made in six sizes with 20 standard bores ¼ to 1½ in. Transmits up to 10 hp at 1800 rpm. Weigh from about 5 oz to 2 lb. **Charles Bond Co, 617-623 Arch St, Philadelphia 6.**

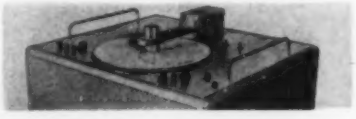
Circle 331, Reader Service Card



Data processor . . .

samples analog voltage information, electronically converts to digits and prints seven channels at rate of 3 per sec. Nixie lamp banks give visual readout. Digital information is printed in three of 11 columns, leaving eight columns for additional data. Accuracy is said to be ±1 digit; range, 000 to 999. Measures 21 x 19 x 16 in. **Gerber Scientific Instrument Co, 89 Spruce St, Hartford, Conn.**

Circle 332, Reader Service Card



Automatic diagram plotter

is self-contained transfer function analyzer for servo system design and testing. Includes low-frequency generator, phase detector and recorder. Plots with amplitude accuracy of 1% and phase angle accuracy of 1°. Completes graph (about 10 in. dia) in 5 mm.; 90 sec if response below 1 cps is not required. Series covers frequency range of 0.025 to 250 cps. **Dept K 51, British Industries Corp, Special Instruments Div, 80 Shore Rd, Pt Washington, NY.**

Circle 333, Reader Service Card

For complete chain drives ¼" to 2" pitch . . .

BOSTON Gear SPROCKETS and CHAIN

FROM STOCK . . . at Factory Prices

Catalog No. 57 lists

ANY TYPE OR SIZE YOU NEED

.81" to 50.94" P.D. SPROCKETS, iron and steel, for single ROLLER CHAIN

1.92" to 26.74" P.D. SPROCKETS, iron and steel, for double ROLLER CHAIN

¼" to 2½" P. ROLLER CHAIN single, double, and triple strand

DOUBLE PITCH ROLLER CHAIN
1", 1¼", 1½" P. Drive Series
1", 1¼", 1½", 2" P. Conveyor Series
1", 1¼", 1½", P. Agricultural Series

1.94" to 12.74" P.D. SPROCKETS, iron and steel, for BLOCK CHAIN
⅛" to ½" w. BLOCK CHAIN

.37" to 6.07" P.D. SPROCKETS, bronze and steel, for LADDER CHAIN
.185" to .353" P. LADDER CHAIN brass and steel

Save machining time

SHOLD-A-GRIP
interchangeable tapered SPROCKETS and BUSHINGS
2.09" to 23.88" P.D. SPROCKETS adaptable with tapered BUSHINGS to shaft sizes ½" to 3" by 16ths

BORED-TO-SIZE
ready-to-install SPROCKET PINIONS
Complete with keyway and setscrew. ⅜" through 1" P., in 86 tooth sizes, with 360 stock bores

Order from your local Distributor. You save time and expense — you get BOSTON Gear top-rated quality and lasting economy. Be cost-wise — standardize. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

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BOSTON Gear®
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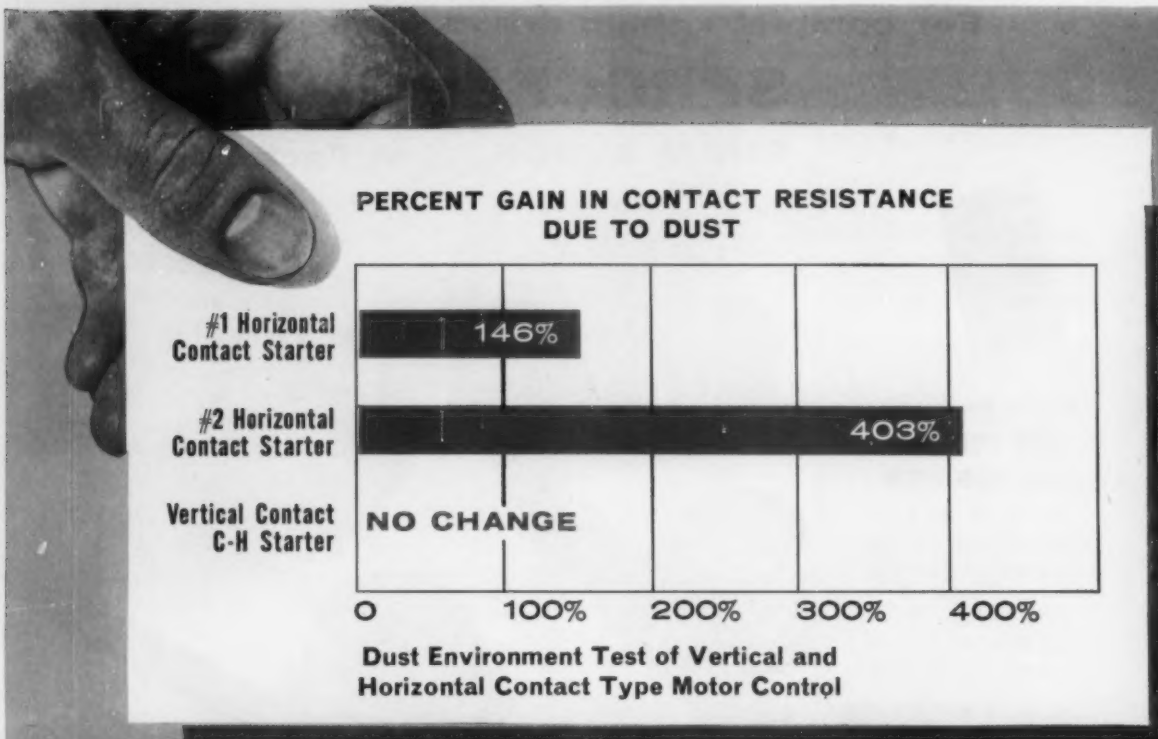
9496 "OFF-THE-SHELF" TRANSMISSION PRODUCTS **FROM STOCK** — AT FACTORY PRICES — ASK FOR CATALOG
Stock Gears • Sprockets and Chain • Speed Reducers • Bearings • Pillow Blocks • Couplings



PROOF OF PERFORMANCE

Vertical *dust-safe* contacts keep Cutler-Hammer Three-Star Motor Control working better...working longer

Standard dust chamber used to compare performance of vertical and horizontal contact type motor starters in dust environments

"Dust can't collect on a vertical surface." This is a simple fact, but an important one to users of motor control. To function properly the contacts in motor control *must* stay clean, free from all forms of dust under all operating conditions. And because dust can't collect on a vertical surface, only vertical contacts are truly *dust-safe*. For proof look at the results of this test.

Both horizontal and vertical contact type motor starters were subjected to a dust environment for four hours. The vertical contacts proved their immunity to dust by maintaining a constant contact resistance. But the contact resistance of horizontal contacts skyrocketed, and as contact resistance increases so does heating, pitting and wear, resulting in rapid contact failure.

These are the facts . . . facts which show you why it's wise to standardize on Cutler-Hammer Three-Star Motor Control with vertical *dust-safe* contacts.

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Cutler-Hammer Inc., Milwaukee, Wis. • Division: Airborne Instruments Laboratory. • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

CUTLER·HAMMER CONTROL C-H

Vertical *dust-safe* contacts are standard in all Cutler-Hammer Three-Star Motor Control

NON-REVERSING STARTERS AND CONTACTORS

CONTROL RELAYS

OIL WELL PUMPING CONTROL

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REDUCED VOLTAGE STARTERS

AND MORE...

Write today for Pub. EN150-S249. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

ELECTROMECHANICAL COMPONENTS—Catalog 60, 512 pp. Features over 20,000 components available from stock. With dimensional drawings, specs, prices. Sterling Precision Corp, 17 Matinecock Ave, Port Washington, NY.

Circle 340, Reader Service Card

PHOSPHOR BRONZE—Handbook, 20 pp. Covers composition, specs and properties of various alloys and discusses facilities for continuous casting of strip. Riverside-Alloy Metal Div, H K Porter Co Inc, Riverside, NJ.

Circle 341, Reader Service Card

COMPRESSED AIR FUNDAMENTALS—Booklet 1548, 16 pp. Basically describes compressed air, how it is compressed, various types, characteristics and operation. Also, compressor oils, pipe and wire sizes, terminology and definitions used in connection with compression of air. Contains tabular and chart information on power requirements and air supply. Ingersoll-Rand Co, 11 Broadway, New York 4.

Circle 342, Reader Service Card

SYNCHROS, SERVO MOTORS, AMPLIFIERS—Catalog, 170 pp. Contains specs and outline drawings of 200 units, including synchros manufactured to latest MIL specs. Covers synchros, servo motors, servo amplifiers, resolvers, rate gyros and potentiometers. Ketay Dept, Norden Div, United Aircraft Corp, Commack, NY.

Circle 343, Reader Service Card

SPRING CLUTCHES—Catalog, 32 pp. Describes five standard lines of spring clutches, bore sizes ¼ to 1 in. with specs, application data, and illustrations to aid in selection of correct type and size. Marquette Div, Curtiss-Wright Corp, 1145 Galewood Dr, Cleveland 10.

Circle 344, Reader Service Card

STANDARD TESTERS—Catalog 59A, 16 pp. Descriptions and illustrations of 73 standard testers or equipment. Custom Scientific Instruments Inc, Kearney, NJ.

Circle 345, Reader Service Card

HIGH-STRENGTH, HIGH-TEMPERATURE STEEL—Brochure, 30 pp. Includes information on heat treatment and physical and mechanical properties. Contains graphs illustrating tensile and yield strengths, temperature properties and stress-rupture curves. Universal-Cyclops Steel Corp, Station St, Bridgeville, Penna.

Circle 346, Reader Service Card

DIRECTIONAL CONTROL VALVES Engineering data sheets, 9. Describes 94 different models of 2- and 4-way directional control valves, including design, operation and function information, schematics, typical circuit applications, flow characteristics, approved JIC symbols and dimensions. Sarasota Precision Products, 1312 N Lime Ave, Sarasota, Fla.

Circle 347, Reader Service Card

MECHANICAL FEEDBACK SERVO VALVE—Catalog 310, 8 pp. Describes operating principles, design features and performance characteristics. Includes schematic, cutaway photo and series of performance curves. Moog Servocontrols Inc, E Aurora, NY.

Circle 348, Reader Service Card

PLATINUM-GROUP METALS – Brochure, 8 pp. Covers platinum-metal products; lists physical and chemical properties of platinum; gives dimensions for products, anodes and gauze. Typical clad metal combinations, thermocouple wire compositions, catalyst forms and stock of salts maintained are enumerated. Metals & Controls Div, Texas Instruments Inc, 34 Forest St, Attleboro, Mass.

Circle 349, Reader Service Card

SHOCK AND VIBRATION ISOLATORS—Bulletin 59-04, 4 pp. Discusses shock, vibration and selection of isolators. Barry Controls Inc, 700 Pleasant St, Watertown 72, Mass.

Circle 350, Reader Service Card

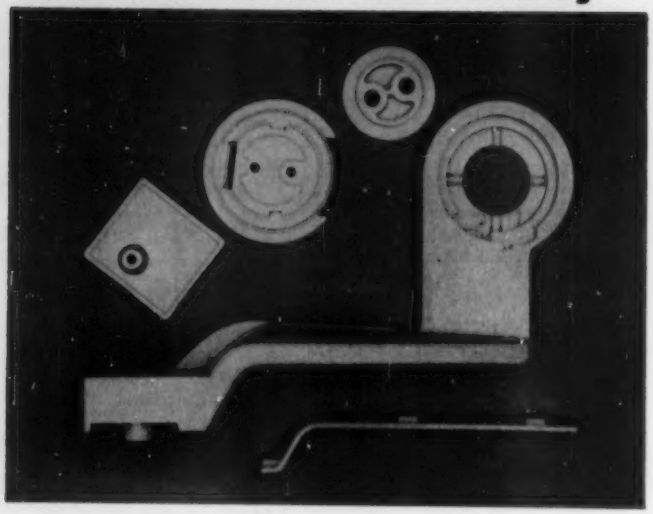
COAL TAR EPOXY COATINGS—Report, 8 pp. Compilation of 17 laboratory tests shows what to expect when coal tar epoxies are exposed to attack of various corrosive solutions and environments. Amercoat Corp, 4809 Firestone Blvd, South Gate, Calif.

Circle 351, Reader Service Card

FABRICATED REINFORCED PLASTIC PARTS—Bulletin 200, 12 pp. Gives physical properties and applications of asbestos-reinforced, thermosetting phenolic resin plastic. Material is often combined with silicone, epoxy and polyester for

(continued on page 112)

POLAROID specified dimensional accuracy



and got it from CONSOLIDATED

Both dimensional accuracy and fine appearance were essential requirements in the production of this camera flash attachment for Polaroid. Naturally, mold planning and construction were of utmost importance in such a critical job. Precision and timing had to be built into the mold design. Three different molds were necessary to produce the five separate pieces which form one synchronized unit.

In assembling the unit, all parts had to be kept in perfect alignment; no warpage or twist was permitted. For appearance's sake, it was necessary to locate mold parting lines on the natural edges of the pieces.

This flash attachment unit represents the type of molding challenge Consolidated welcomes. We appreciate the opportunity to quote on any molding – complicated or simple.

The Polaroid Bounce Flash Bracket (Model #292), with swivel-type flash gun clip, permits the taking of both horizontal and vertical pictures without removing the gun to change its position.

For more than 80 years we have been filling exacting plastics orders for the nation's blue chip companies. Before you discard any design you feel can't be molded in a plastic, call Consolidated.

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Catalogs and Bulletins.....continued

some applications. Raybestos-Manhattan Inc, Equipment Sales Div, Bridgeport, Conn.

Circle 352, Reader Service Card

RIGID POLYETHYLENE—Brochure, 22 pp and data sheets. Discusses applications of the material. Data sheets include physical and chemical properties, characteristics and information on processing and application. Phillips Chemical Co, Plastics Sales Div, Bartlesville, Okla.

Circle 353, Reader Service Card

RUBBER CONTACT WHEELS—Catalog CWIR659, 16 pp. Data on selection and application of rubber contact wheels and industrial rollers for abrasive belt grinding and finishing. Chicago Rubber Co, Inc, 651 Market St, Waukegan, Ill.

Circle 354, Reader Service Card

MARKING EQUIPMENT FOR ELECTRICAL/ELECTRONIC PRODUCTS—Catalog, 12 pp. Describes methods and equipment for marking all types of electrical and electronic products. Product index guides selection. Special sections also describe machines for UL manifest label legend marking, color banding, screen process printing, tape and label printing, wire and tube marking. Aids in obtaining best combination of machine, ink and printing element. Markem Machine Co, Keene 45, NH.

Circle 355, Reader Service Card

WELDED ASSEMBLIES—Brochure, 6 pp. Describes welded assembly technique for high-density packaging of electronic components. Industrial Tube Div, Raytheon Co, Dept 2528, 55 Chapel St, Newton 58, Mass.

Circle 356, Reader Service Card

SILVER-CADMIUM BATTERIES—Brochure, 6 pp. Supplies physical and electrical characteristics of cells, as well as numerous graphs comparing performance with that of other types of batteries. Yardney Electric Corp, 40-50 Leonard St, New York 13.

Circle 357, Reader Service Card

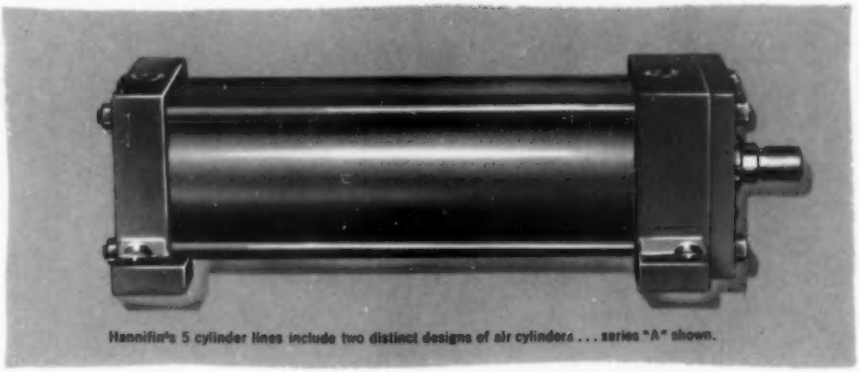
MINIATURE TEMPERATURE CONTROLS—Brochure MC-182, 4 pp. 19 different controls are described with dimensions, temperature range, electrical rating and available modifications. Fenwal Inc, Pleasant St, Ashland, Mass.

Circle 358, Reader Service Card

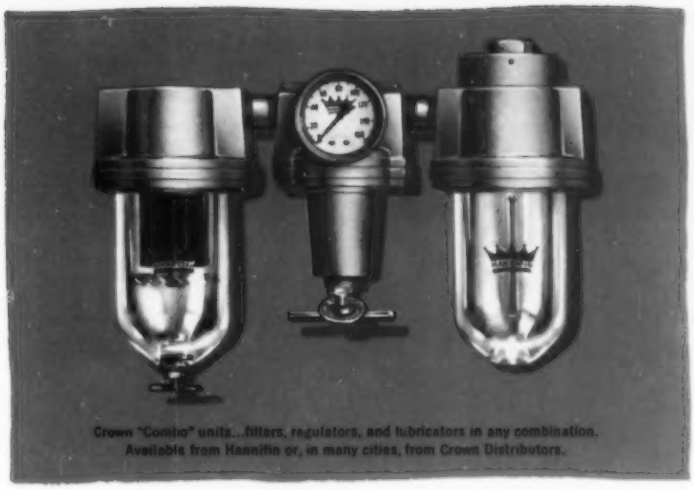
FREE-MACHINING STEEL—Bulletin, 8 pp. Mechanical properties, analysis and machinability rating of free-machining, stress-stabilized, cold-finished steel bar are presented in series of tables. Some appli-

(Continued on page 115)

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS



Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



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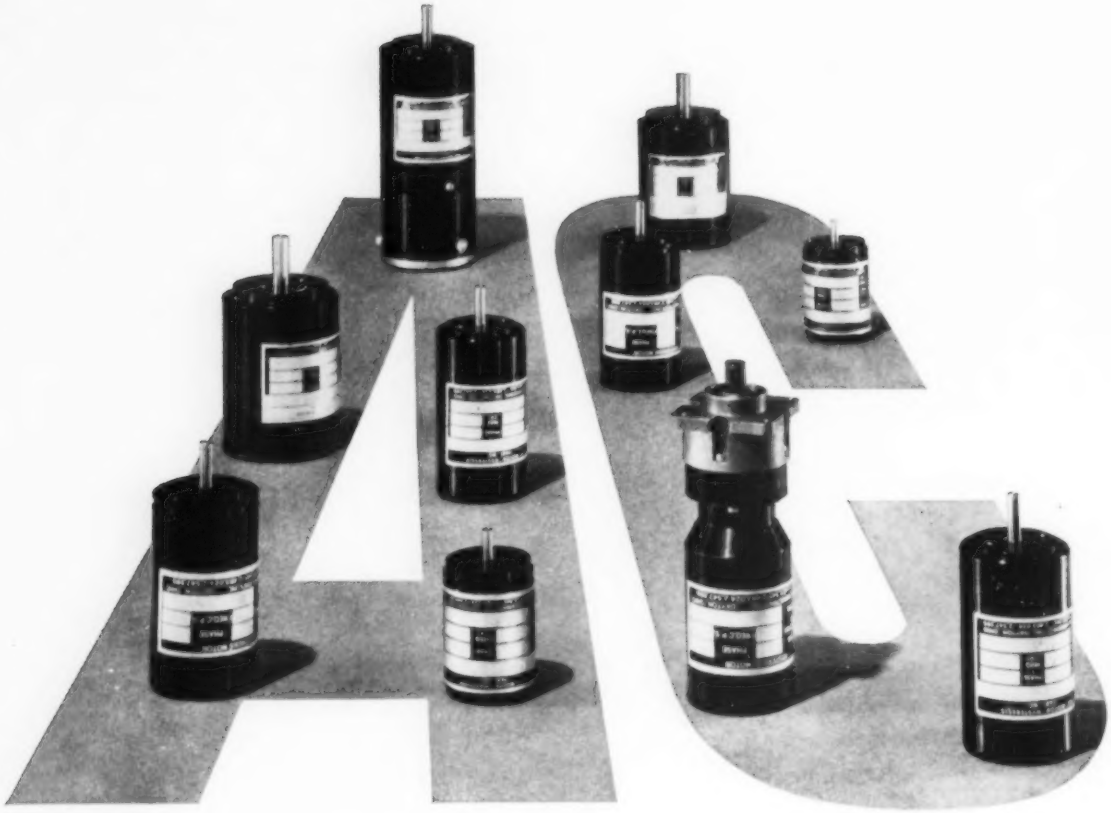

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cations are listed. Jones & Laughlin Steel Corp, 3 Gateway Center, Pittsburgh 30.
Circle 359, Reader Service Card

TRANSISTORS—Specification folder with chart insert, 4 pp. Tabulated specifications on most-popular EIA-registered transistor types for original equipment manufacturers. Chart shows case style, polarity, and characteristics. General Transistor Corp, 91-27 138th Pl, Jamaica 35, NY.
Circle 360, Reader Service Card

WELDED STEEL PULLEYS—Booklet 2540, 8 pp. Gives data on construction, specifications and table of pulley sizes and weights. Information also on lagged pulleys, shaft and pulley assemblies. Link-Belt Co, Dept PR, Prudential Plaza, Chicago 1.
Circle 361, Reader Service Card

TIME-DELAY RELAYS—Folders SM-2 and SR-10, 4 pp each. Covers miniature time-delay relay and dial-head time-delay relay. Gives specifications, descriptions, dimensions and design features. AGA Div, Elastic Stop Nut Corp of America, Elizabeth, NJ.
Circle 362, Reader Service Card

CASTABLE POLYURETHANE RUBBER—Booklet S-5125, 8 pp. Gives properties, characteristics and application information on new rubber compound. Goodyear Tire & Rubber Co, Dept 794, Akron 16.
Circle 363, Reader Service Card

PRINTED WIRING TAPES—Brochure M-24, 4 pp plus price list. Descriptions, dimensions and illustrations of masking aids, including tape as narrow as $\frac{1}{32}$ in. wide. By-Buk Co, 4314 W Pico Blvd, Los Angeles 19.
Circle 364, Reader Service Card

AUTOMATIC POWER LUBRICATION SYSTEMS—Catalog 50, 24 pp. Includes illustrations and specifications of air, vacuum and manually operated systems, their applications, methods of operation, and listings of component parts and accessories. Lincoln Engineering Co, 4010 Goodfellow Blvd, St Louis 20.
Circle 365, Reader Service Card

EQUIPMENT CONTROL CONNECTORS—Bulletin 372, 12 pp. Describes construction features, gives dimensions, specifications and examples of typical applications. Joy Mfg Co, Electrical Products Div, 1201 Macklind Ave, St Louis 10.
Circle 366, Reader Service Card

PLASTICS—Booklet, 12 pp. Revised edition describes properties and typical end
(Continued on page 118)

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Choose exactly the properties you need. Garlock's Plastics Division, The United States Gasket Company, makes many varieties of Chemiseal® Nylon Rod, each with different qualities for different applications. For example:
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SPLINE DRIVE
ARMATURE reduces brake and clutch maintenance on high-cycle applications

Heavy shock loads are no problem for Warner electric brakes and clutches—not with this new spline drive armature.

Impact is distributed evenly on multiple splines. Wear is all but eliminated, even on heavy-duty, high-cycle applications.

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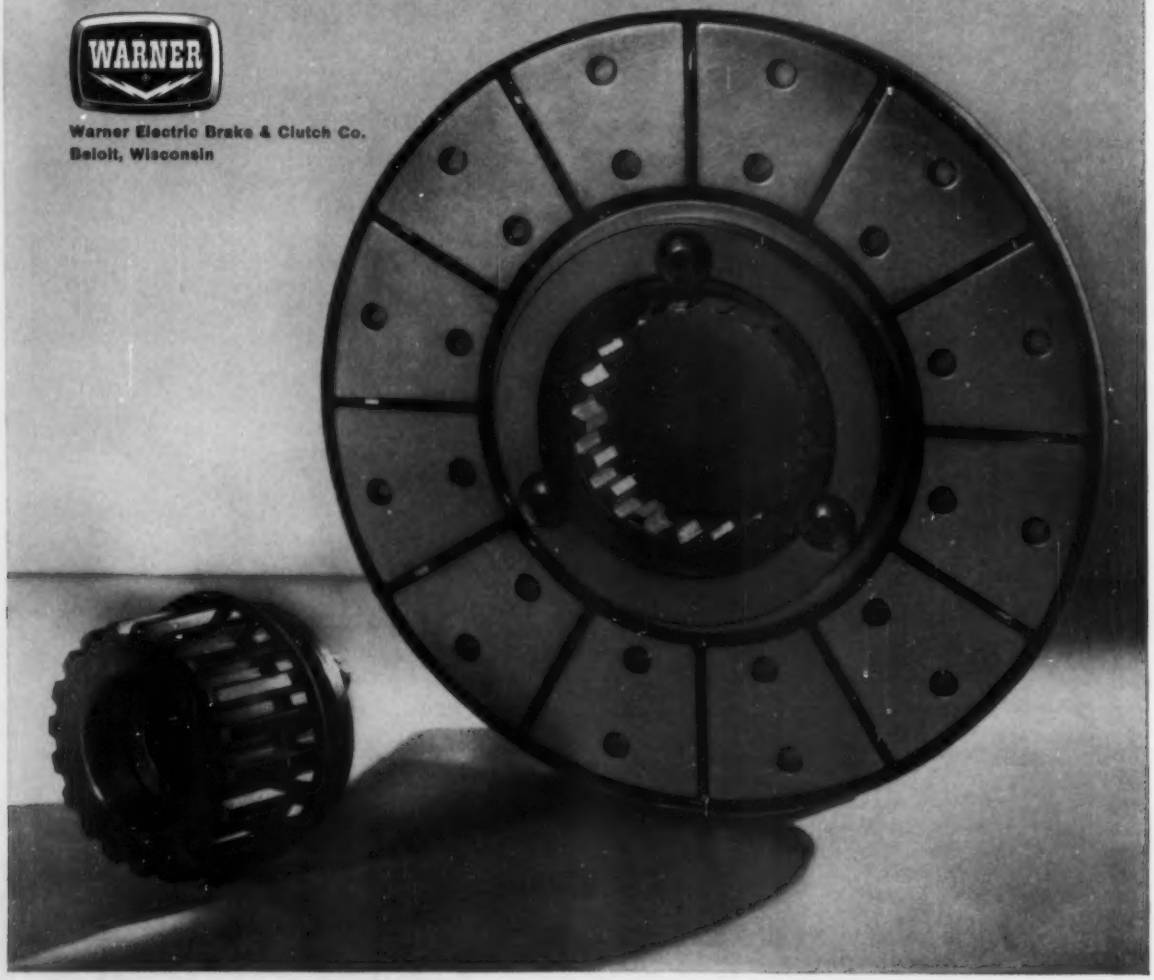
The beauty of Warner's new armature drive is its ease of installation. To align it, you just press the armature against the magnet face. There are no complex adjustments to make. Clearance is preset for initial installation—automatic from that point on.

Thus, for about the same installed cost, you can put a higher quality component on your machine drive—protect your customer against wear problems caused by rapid, continuous cycling of high torque loads.

Spline drive armatures are now available from stock for Models 825 to 1525 Warner electric brakes and clutches. For complete specifications, write for Bulletin P-68.

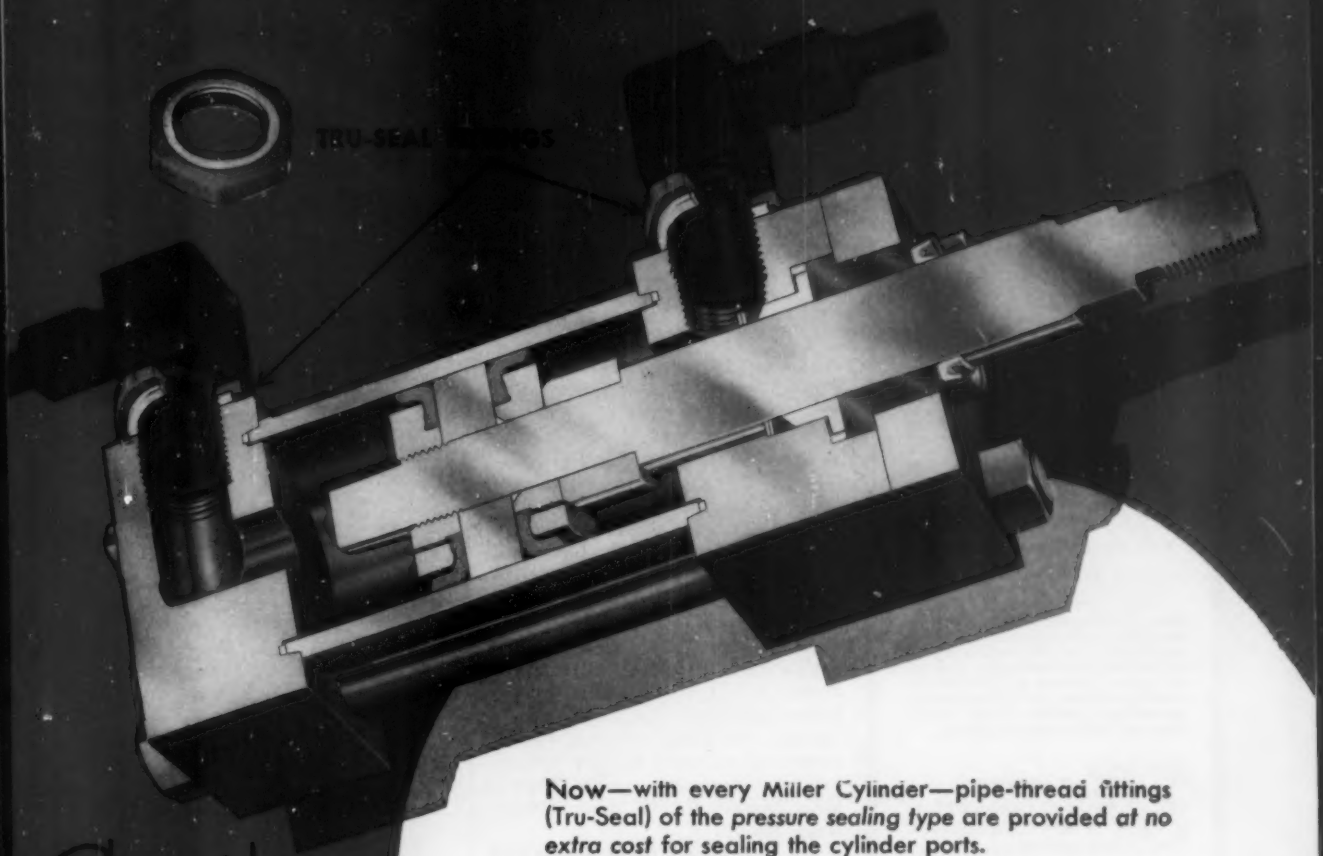
WARNER

Warner Electric Brake & Clutch Co.
Beloit, Wisconsin



CIRCLE NO. 117 READER SERVICE CARD→

NOW... even the PORTS have seals of the PRESSURE SEALING TYPE!



Now—with every Miller Cylinder—pipe-thread fittings (Tru-Seal) of the *pressure sealing type* are provided *at no extra cost* for sealing the cylinder ports.

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uses of diversified line of plastics. Includes results of ASTM tests. Monsanto Chemical Co, Dept 1331, Springfield 2, Mass.
Circle 367, Reader Service Card

ELECTRIC CLIPS, INSULATORS—Catalog 220, 8 pp. Lists and illustrates line of electric clips, from miniature to welding ground clamps. Mueller Electric Co, 1553W E 31st St, Cleveland 14.
Circle 368, Reader Service Card

FRETTING CORROSION — Bulletin 7102, 6 pp. Several ways in which wear by fretting corrosion in variable-speed sheaves can be controlled are discussed by Eldon L Nuernberger, chief engineer. T B Wood's Sons Co, Chambersburg, Penna.
Circle 369, Reader Service Card

MOTOR FOR SLIP STEM VALVES—Specification S1016-2, 8 pp. Describes motor with integral strain release and yoke assembly. Minneapolis-Honeywell Regulator Co, Industrial Div, Wayne & Windrim Aves, Philadelphia 44.
Circle 370, Reader Service Card

STAINLESS FLEXIBLE HOSE—Folder SSDS-562, 4 pp. Gives engineering information and tabular data on pressure, flexibility, suggested usage, formulas for determining lengths. Threaded and flanged end fitting connections are diagrammed. Allied Metal Hose Co, 3761 9th St, Long Island City 1, NY.
Circle 371, Reader Service Card

ADJUSTABLE STROKE CYLINDERS—Bulletin 112, 4 pp. Covers air and hydraulic applications. Contains dimensional data and engineering drawings of available mounts and accessories as well as specs for ordering or requesting quotes. Ortman-Miller Machine Co, 19 143rd St, Hammond, Ind.
Circle 372, Reader Service Card

REDUCED VOLTAGE STARTERS—Bulletin GEA-6860, 8 pp. Defines, tells when and where to use and how to select reduced-voltage equipment. Includes starter selection table, comparison table and photos with callouts. General Electric Co, Schenectady 5.
Circle 373, Reader Service Card

SHAPED WIRE—Technical bulletin T-2, 4 pp. Lists properties, advantages and some applications of special shaped alloy wire. Concerned primarily with nickel alloys and stainless steels. Riverside-Alloy Metal Div, H K Porter Co, Riverside, NJ.
Circle 374, Reader Service Card

OPEN-GEAR LUBRICANT—Pamphlet, 6 pp. 16 grades of all-weather lubricant

(Continued on page 122)

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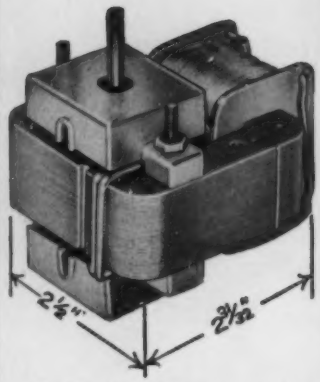

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DIE-CAST BEARING BRACKET This new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

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T-J TOMKINS-JOHNSON

CIRCLE NO. 119 READER SERVICE CARD 119

CASE HISTORIES FROM MT. VERNON FILES

University makes 3 speakers from 1 Mt. Vernon die casting

The advent of stereo has brought about a demand for smaller cabinets and posed a problem for speaker engineers: design a small moderately priced unit capable of sound reproduction as good as that of present day speaker systems 3 to 4 times its size.

University engineers came up with 3 answers—3 new 8 inch speakers with outstanding performance characteristics—made of highest quality materials, with a better finish than ever...all at greatest possible economy thanks to the use of Mt. Vernon Die Castings.

This zinc pressure die cast "basket" provides a universal 8" frame for three different speakers: 1—a full range 3 way diffaxial, 2—a standard woofer, and 3—a new type high compliance woofer. This single part, formerly made of several stampings, contains the supports, flanges, slots, ribs, holes, studs and channels for all three models. It possesses all the rigidity and dimensional stability needed to assure permanent centering of the speaker coné, voice coil and magnetic element at increased power ratings.

Designed to very close tolerances, the castings are dependably uniform from speaker to speaker. They offer better design, greater rigidity and reliability than the assembled stamped basket at no increase in cost. Best of all, final speaker assembly is speeded up with fewer steps, resulting in greater economies, enabling University to offset steadily increasing general production costs. The finished products have a superior quality look that matches their superlative performance.

Back and front the casting is intricate, and the die even more so. However, Mt. Vernon's complete fourfold service takes these complex casting assignments in stride, gives service that more than satisfies...service that keeps customers happy for years and years...in the case of University Loudspeakers, Inc., of White Plains, N. Y....for over 15 years.

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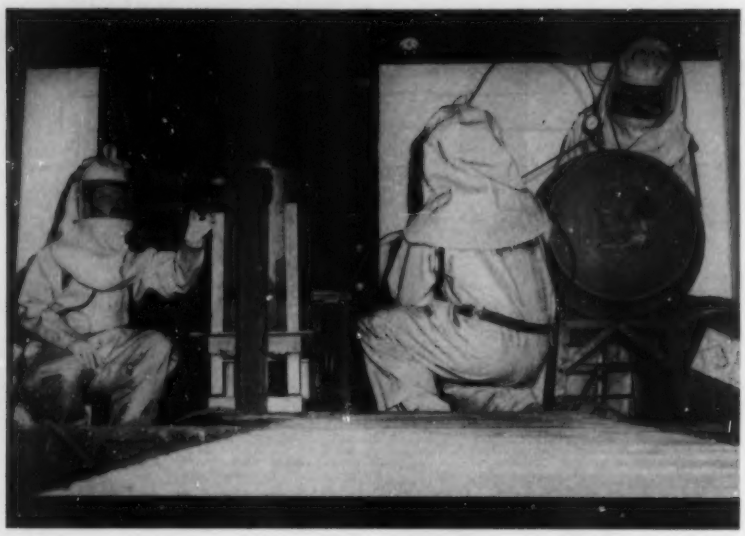

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for outdoor equipment are listed. Provides grade recommendations. Gredag Dept, Acheson Colloids Co, Port Huron, Mich.
Circle 375, Reader Service Card

ROLLER CHAIN FLEXIBLE COUPLINGS—Bulletin 597, 8 pp. Information on advantages and proper selection. Illustrates installation and maintenance procedures. Chain Belt Co, Milwaukee 1.
Circle 376, Reader Service Card

GEARMOTORS—Bulletin 51B9172, 8 pp. Covers design and construction features of ¼ to 100 hp gear motors, integral and all-motor types. Allis-Chalmers Mfg Co, Milwaukee 1.
Circle 377, Reader Service Card

ELECTRIC CIRCUIT CONTROL TIMERS—Catalog, 4 pp. Lists various timers, with design and construction features, dimensions, and typical applications for use as selection guide. Miller-Harris Instrument Co, 601 E Ogden Ave, Milwaukee 2.
Circle 378, Reader Service Card

COLD EXTRUDED METAL PARTS—Bulletin, 4 pp. Treats process of producing cold extruded metal parts, their physical characteristics, mechanical properties, economies and applications. Burgess-Norton Mfg Co, Geneva, Ill.
Circle 379, Reader Service Card

COMPRESSION TERMINALS—Bulletin SDT-59-101, 6 pp. Selection guide for choosing proper glass-to-metal hermetically-sealed terminals. Includes electrical specifications, installation data. Electrical Industries, Div Philips Electronics Inc, 691 Central Ave, Murray Hill, NJ.
Circle 380, Reader Service Card

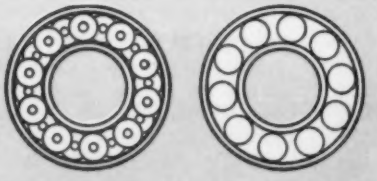
PACKAGED MODULAR CONTROL SYSTEMS—Bulletin PS-5A, 4 pp. Contains charts and photos of units in system and describes operation. Systems originally designed for electronic control, aircraft and related fields. Airborne Accessories Corp, 1414 Chestnut Ave, Hillside 5, NJ.
Circle 381, Reader Service Card

COMPRESSED AIR COMBINATION UNITS—Circular 1014, 2 pp. Covers filtering, regulating and lubricating components for compressed air circuits. Operation, and specifications for popular models and sizes. Wilkerson Corp, 1656 W Girard, Englewood, Colo.
Circle 382, Reader Service Card

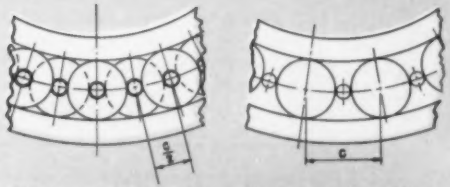
MAGNETIC CLUTCHES, BRAKES—Brochure, 4 pp. Lists line of magnetic clutches and clutch-brakes. Includes descriptions, ratings, general specifications
(Continued on page 124)

These SHORT, STAGGERED ROLLERS provide HIGHER LOAD CAPACITY SMOOTHER RUNNING LONGER BEARING LIFE

ORANGE *STAGGERED* ROLLER BEARINGS



More rollers support the load. End views of Staggered Roller bearing (left) and the conventional bearing, show how many short rollers distribute the load over a multiplicity of contact points within the loaded zone.



Closer centers—smoother running. Short, staggered rollers have half the chordal distance of fewer long rollers. More pins add greater rigidity to the cage.

Reduced roller skewing and edge loading. Each row of short rollers aligns itself independently. Under angular misalignment, a short roller can skew only a fraction of a longer roller. In dimensional deviations of component parts or uneven loading, short rollers are much less affected by edge loading thus provide better fatigue life.

Orange Staggered Roller Bearings, with many short rollers in staggered arrangement instead of fewer long rollers, bring you many advantages over conventional bearings.

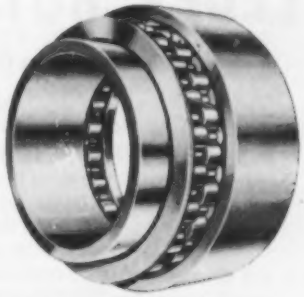
IN HEAVY-DUTY APPLICATIONS the higher load capacity of Orange Staggered Roller Bearings permits the use of smaller bearings, thus saving space and weight. Replacing present bearings, same size, adds extra capacity and longer bearing life.

IN PRECISION APPLICATIONS requiring extremely smooth rotation (such as rolling sheet or foil, rotogravure printing, etc.) the even distribution of load over many contact points provides exceptionally smooth running.

200 and 300 Series. Separable three-part construction—outer race, roller assembly, inner race. Choice of widths and lengths to suit conditions.

C-200 and C-300 Series. This series denotes bearings without inner races for operation on properly hardened and ground shafts.

T-200 and T-300 Series. Designed for use on standard commercial cold drawn shafts. Available for slip fit with inner race notched, or for press fit without notches.



Available in a complete range of sizes interchangeable with other bearings in the 200 and 300 series.

Write for the new 48-page Engineering Reference Manual giving specifications on complete line of Orange Roller Bearings.

ORANGE ROLLER BEARINGS

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Needle Bearings — Staggered Roller Bearings
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In Europe: NSF Ltd., 31-32 Alfred Pl., London, England; NSF, GmbH, Nurnberg, Germany

and dimensional drawings. Dynamic Instrument Corp, 59 New York Ave, Westbury, NY.

Circle 383, Reader Service Card

REMOTE IMPULSE COUNTERS – Data sheet, 2 pp. Illustrates and describes series of electric impulse counters, available in 4 and 5 digit models. Landis & Gyr Inc, 45 W 45th St, New York 36.

Circle 384, Reader Service Card

COUPLINGS–Bulletin 62, 2 pp. Includes diagrams of Series X dihedral coupling and parts, table of sizes and bores and information on design and construction. John Waldron Corp, PO Box 791, New Brunswick, NJ.

Circle 385, Reader Service Card

DEEP-DRAWN PARTS–Bulletin, 2 pp. Offers basic information on use of deep-drawn parts in production and tells which metals can be specified. Also covers basic shapes. Pressed Steel Tank Co, 1445 S 66th St, Milwaukee 14.

Circle 386, Reader Service Card

LIQUID-LEVEL CONTROLLER – Folder S1017-1, 4 pp. Gives description of transistor-equipped electronic amplifier relay for control of any electrically conductive liquid with resistance below 25,000 ohm. Minneapolis-Honeywell Regulator Co, Industrial Div, Wayne and Windrim Aves, Philadelphia 44.

Circle 387, Reader Service Card

AUTOMATIC TRANSFER SWITCH– Bulletin 07500-G, 4 pp. Highlights transfer switches with dual circuit breaker design that permits mechanical transfer of power by common motor-driven linkage. Lake Shore Electric Corp, 205 Willis St, Bedford, Ohio.

Circle 388, Reader Service Card

"Pencils, pencils, pencils. No wonder it costs so much to design a rocket!"

ABRASION PROBLEMS?

To get down to hard facts—Coors Space Age Ceramics are among the hardest common materials known! They are harder than silicon carbide and are comparable to sapphire, having a hardness rating of 9 on Moh's Scale and a Knoop Hardness Factor of 1450 to 1750.

This means that if abrasion is likely to cut short the service life of the part you are designing, it will pay you to consider using Coors High Alumina Ceramic.

Of course, it is the extreme hardness and toughness of Coors Aluminas that provide superior resistance to wear and abrasion. But just as important in the design of a part are other properties. Coors Aluminas have outstanding mechanical strength—up to 34,000 psi tensile strength and over 300,000 psi compressive strength. They have permanent dimensional stability, superior impact resistance, are chemically inert and they can be fabricated to extremely close tolerances. Typical applications:

Seal Rings

Mechanical rotary seals are fast replacing the conventional stuffing box and packing gland in preventing leakage of liquids along the rotating shafts of pumps, agitators and similar equipment—abrasive applications as tough as they come.

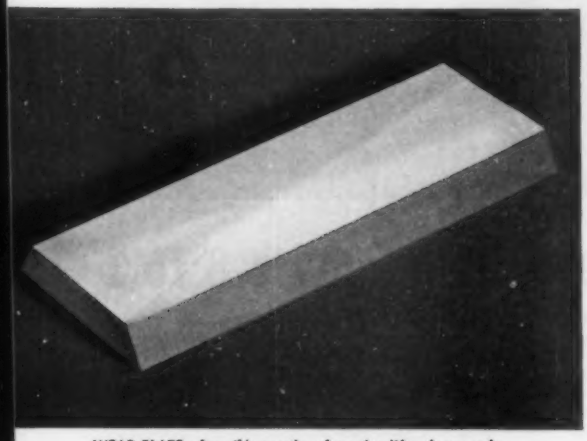
Many thousands of these seal mechanisms are now being made with Coors High Alumina Ceramics as one of the two seal surfaces—the other surface being a graphite composition or a plastic such as nylon or teflon. Under special conditions, with pressures below 25 psi, an exceptionally good seal is obtained by running ceramic against ceramic—possibly because lapped surfaces can be made on the ceramic parts to 2 or 3 light bands of flatness. Most liquids act as a good lubricant because the ceramic is chemically inert.

Dependability of Coors Aluminas in seal rings is demonstrated by the fact that they are widely used with radioactive or toxic material.

MECHANICAL SEAL RING

Standard Production Tolerances
Coors Ceramic Seal Rings

Flatness—Running Face ground and lapped to 3 light bands.
Parallelity of faces—within .002" T.I.R.
Concentricity—.005" T.I.R.
Outside Diameter—±.005"
Thickness—±.005"



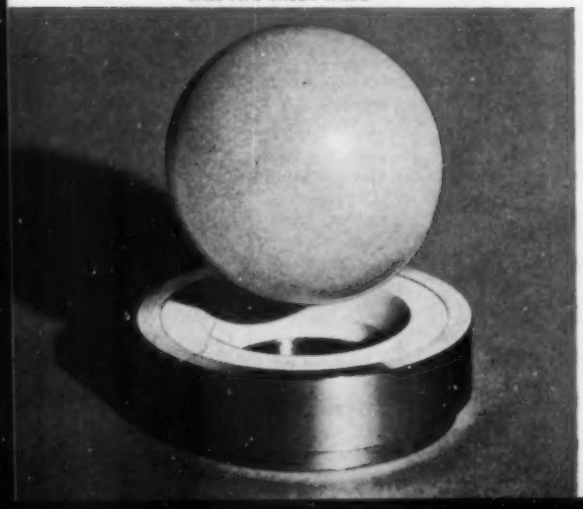
WEAR PLATE after 4½ months of service life, shows only slight wear. This Coors Ceramic plate replaced a plate of hardened tool steel which lasted only two days.

Wear Plates

Because of the extreme hardness of Coors High Alumina Ceramics, even swarf consisting of cutting oil, aluminum oxide cutting wheel grit and steel cuttings has little effect in cutting or abraiding parts made from the ceramic. This wear plate, for example, on a Production Centerless Belt Grinder was originally hardened tool steel. In grinding a .015" cut in steel tubing for precision hydraulic cylinders, grooves .05" deep were worn in the steel wear plate by the swarf in only two days, causing a loss of the required grinding tolerance. Now, made of Coors High Alumina Ceramic, wear in 4½ months has amounted to only .01"—the same wear put on the steel plate in a few hours!

Other applications range from oil field uses for metering chokes, mud gun nozzles and rock bit nozzles all the way to nose cones for missiles.

BALL TYPE CHECK VALVE



Ball Type Check Valves

Replacement of metal valve seats with Coors High Alumina Ceramic provides improved operation of filter press pumps. Metal seats previously used have lasted as little as three weeks in service. Valve seats made by Coors, inspected after months of service, show no sign of wear.

This is typical of applications where abrasive slurries are being controlled with ball type check valves using Coors Ceramic. For best results, both a Coors ceramic ball and seat are used. Coors Ceramic is chemically inert, so this type of valve is also useful for acid or some alkali applications. (Spherical ground balls of Coors AD-85 Ceramic are kept in stock. Special tolerances on balls extend up to ±0.000020".)

Coors offers a complete engineering service to assist you in utilizing these high strength ceramics to the best advantage. For complete properties and specifications, write for Bulletin 858.

Coors

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600 Ninth Street, Golden, Colorado

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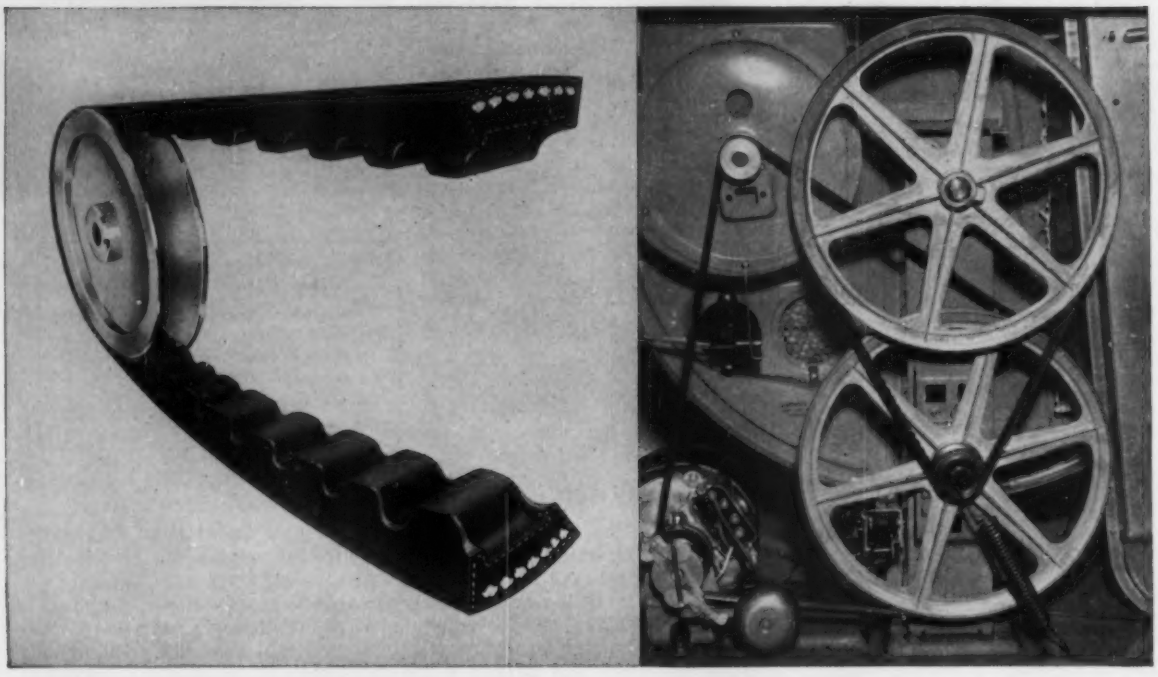
Passaic, N.J.



NOW...A NEW DESIGN IN LUGGED V-BELTS

Outlasts Other Belts as Much as 8 to 1

R/M introduces new CX V-Belt . . . *the only fully molded, fully jacketed lugged belt*. Extensive tests have proved it outperforms, outlasts other makes of belts as much as 8 to 1. Fully molded and full fabric cover prevents flex-cracking, improves fatigue resistance, has less distortion because of lateral stability, maintains more effective length. It's the ideal lugged belt for small pulleys where flexibility and ruggedness, with extremely quiet running, are important factors.

Other R/M V-Belt Designs

R/M engineering makes other V-belts to meet a wide variety of light and heavy duty requirements. For example, R/M FHP V-Belts eliminate troublesome vibration problems on motorized appliances, air conditioners, power tools. An exclusive molding process positions and controls every belt part to assure balanced belt power delivery without whipping or slapping.

On heavy duty multiple belt drives. Condor V-Belts with flat sidewalls assure *more* grip, *less* slip . . . longer belt life.

Now transmit 40% more power than conventional V-belts at no increase in cost. Condor V-Belts give you premium V-belt construction at standard V-belt prices.

For space saving, no matching problems, and other advantages use the patented R/M Poly-V Drive, a revolutionary new concept in heavy duty power transmission.

Let R/M rubber specialists work with you on V-belts, transmission or conveyor belting, rubber hose, molded or extruded parts.

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Bridgeport, Conn.

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Complete information on packings shown and many others is given in free booklet. Send for it today.
Packing Division,
Raybestos-Manhattan, Inc.
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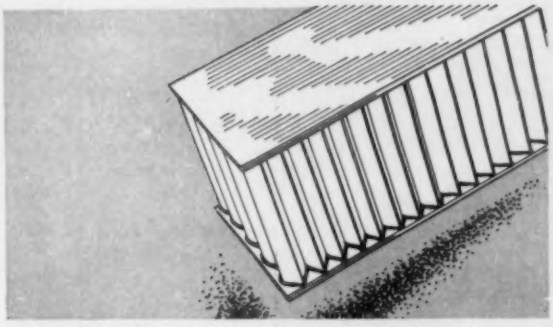

Resin-treated paper bonding to metal saves weight in this honeycomb.

Bonding polyethylene plastic firmly for use in sewer and irrigation pipe.

Cutting Costs—and Corners in Product Assembly

With costs up and profits down, today is a better time than ever to check the advantages of adhesive bonding.

R/M Ray-BOND® Adhesives are now speeding assemblies and saving money in a broad range of different applications. Ray-BOND Adhesives have excellent bonding qualities and heat stability. They resist temperatures from −80°F to +700°F—give superior performance in meeting widely varied requirements, under many different destructive liquids, gases, atmospheres and physical conditions. And they have an impressive record for simplifying assemblies that were formerly difficult or impossible.

With over 20 years' pioneering in the production of bonded assemblies and the manufacture of adhesives and coatings, Raybestos-Manhattan is in a special position to demonstrate what adhesive bonding could do for you. Write for more specific information on your business letterhead now.

R/M Fabric Piston Cups

R/M Vee-Flex Rings

Controlled molding assures dimensional uniformity in R/M Piston Cups and "V-Rings"

R/M piston cups for hydraulic and pneumatic cylinders are designed and precision molded from a wide variety of modern synthetics to give maximum service with a minimum of friction. The clearly defined contours and cleanly trimmed edges assure strict adherence to industry's standard sizes. They are produced in varying degrees of hardness for pressures up to 1500 psi. Our engineers will gladly recommend the proper R/M piston cup for your specific operating conditions.

R/M Vee-Flex® packing rings, for use on steam or air rods, hot oil pumps, hydraulic cylinders, rams, presses, lifts, and a wide variety of other equipment, and precision molded in five types in varying degrees of hardness. They are self-sealing and self-adjusting for pressures up to 1500 psi.

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Teflon Tape, Packings, Sheets, Rods, Tubes

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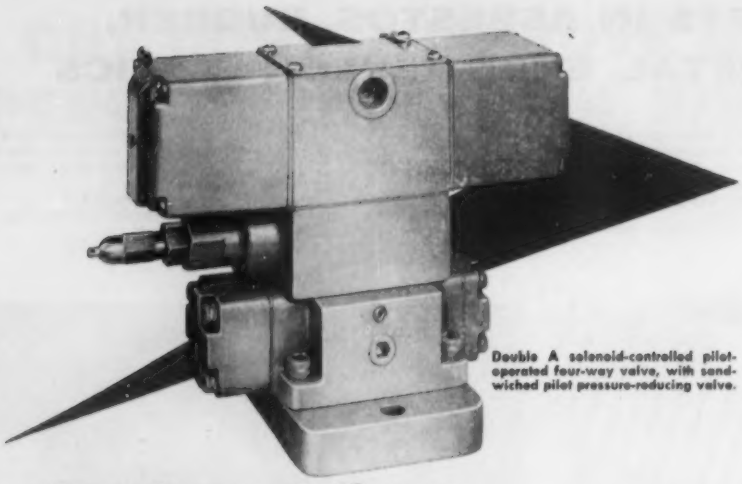

Double A solenoid-controlled pilot-operated four-way valve, with sandwiched pilot pressure-reducing valve.

From Brown & Sharpe–

These Big Double A Valve Features

Get *all* the features *you want* in the valves you buy. Get JIC standards *plus* these extra features and choices by buying Double A solenoid-controlled, pilot-operated directional valves:

- **Choose from four different solenoids: AC, DC, AC oil-immersed, and DC with palm-button.**
- **Solenoids have rubber shock absorbers and exclusive separate drain for more reliable, faster action.**
- **Just one solenoid and pilot valve combination will serve four valve bodies with pipe connections from ⅜" through 2", and three pressure capacities (2,000, 3,000, and 5,000 psi).**
- **New optional CircuitStak pilot pressure-reducing valve sandwiches between main body and pilot valve to make possible higher pressure operation of the main valve body.**
- **New optional CircuitStak pilot flow-amplifying valve requires no piping, provides faster spool shifting of larger valve sizes.**
- **Fifteen different standard cataloged main valve spool types are available, to accurately match your demands.**
- **Two kinds of sub-plates, the usual back-entering plus the back-and-side entering type, are offered.**
- **SAE straight thread openings are optional at no extra cost.**

See for yourself how much more Double A valves offer, from the sensible flow ratings (based on *minimum* pressure drops) right down to the extra mounting bolts (to prevent O-ring troubles under high pressures). Contact your nearest Double A hydraulic distributor. Or write to **Double A Products Co.**, a subsidiary of Brown & Sharpe Mfg. Co., Manchester, Michigan.

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HYDRAULICS DIVISION

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DOUBLE A VALVES
GEROTOR PUMPS
POWER UNITS

PROGRESS IN PRECISION FOR OVER 125 YEARS

COMPLETE INFORMATION on Double A solenoid-controlled sub-plate mounted four-way valves.

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Equipment Says it in Color
How eye-catching color code conveys information from machine to operator. Sept 14 **Circle P 5**

New Data for High-Pressure Air
Properties of air under pressure. Curves useful from 0 to 12000 psi and −150 to 250 F. Sept 14 **Circle P 4**

Latest in Slip Clutches
Describes two new designs, one of them a dual-spring type. Aug 31 **Circle P 3**

What Is Creativity
Latest methods for measuring, controlling and stimulating creativity in R&D. Aug 24 **Circle P 2**

Porcelainized Cast Aluminum
How low-temperature fits may be applied to permanent-mold castings and sheet aluminum. Aug 17 **Circle P 1**

Liquid Spring Saves Space
What it can do and how to use it. Aug 17 **Circle E 100**

Fiberglass Sleeve Springs
Their high energy-absorbent characteristics are shown by charts and equations. Aug 17 **Circle E 99**

Job Hunting and Keeping
How to prepare a resume, handle Personnel and get the right salary. July 27 **Circle E 98**

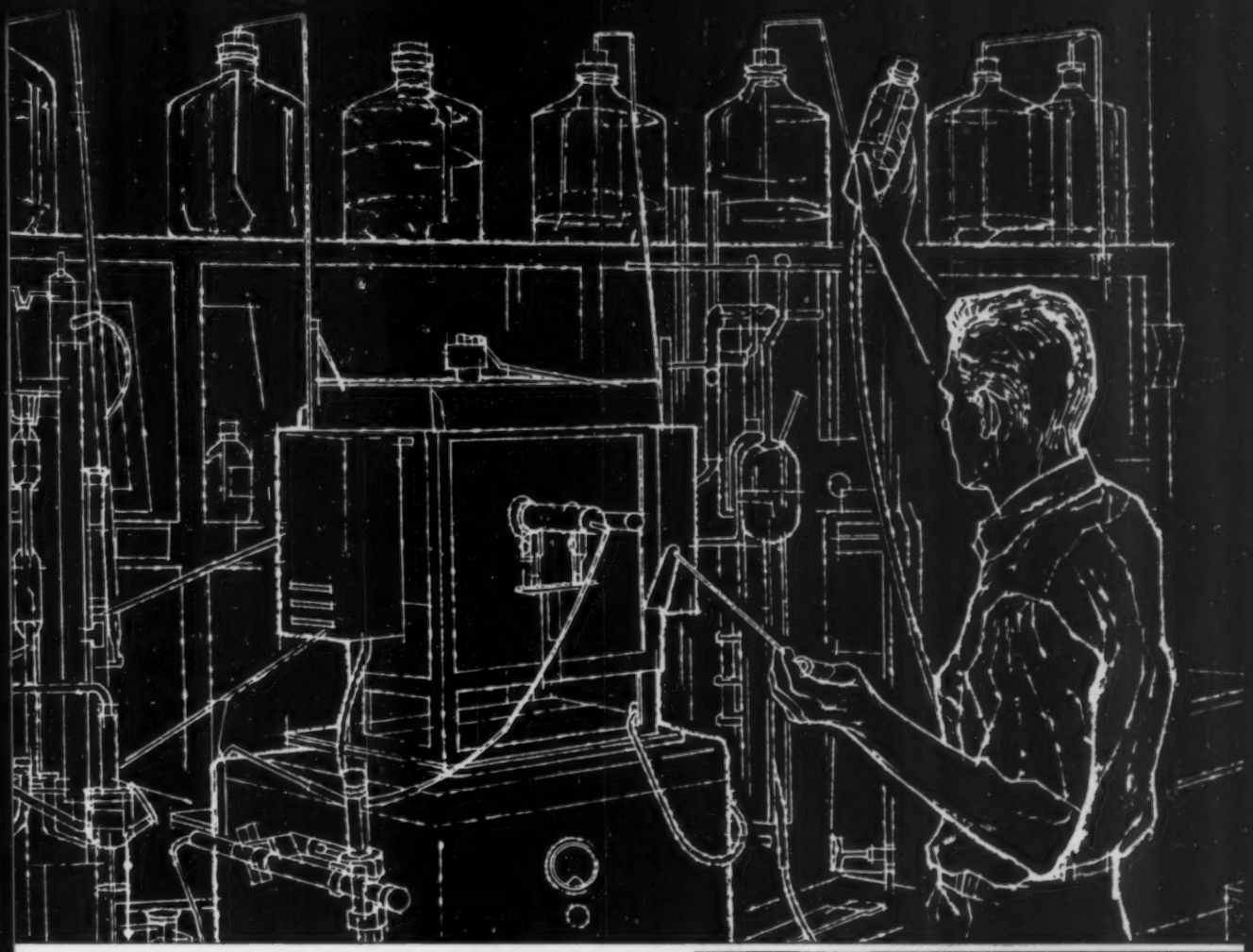
Flameproofing the Product
Latest data on tests and treatments that increase resistance to fire damage. Aug 3 **Circle E 97**

Dry-friction Damped Isolators
For vibration problems, these isolators can outperform the more popular "viscous type. Aug 3 **Circle E 96**

Filament-reinforced Plastics
Filament-winding method bids for mass-production jobs. July 20 **Circle E 95**

Acoustoelasticity
This important new technique analyzes stress by ultrasonics. July 20 **Circle E 94**

(Continued on page 132)



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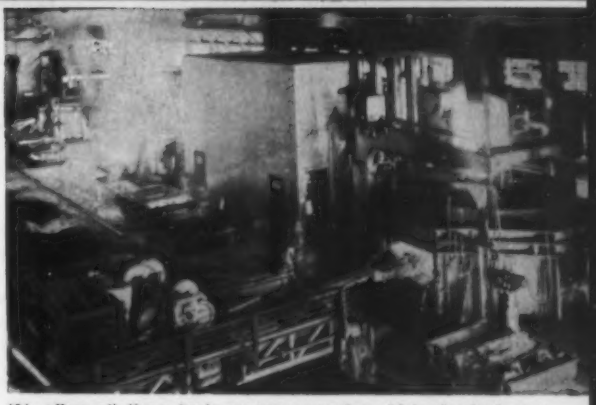
J&L's leadership in the use of basic oxygen converters, high standard open hearth practice and electric furnaces permits melting to more accurate analysis ranges than usually considered necessary. Above all, they assure cleanliness with residuals and inclusions held to a minimum.

With an organization experienced in specialized strip steel processing, your standard or most rigid specifications can be met consistently.

For your convenience, precision strip facilities are available to you in our plants at Youngstown, Indianapolis, Los Angeles and Kenilworth (N. J.)



J&L offers all three—basic oxygen converters, high standard open hearth practice and electric furnace melting to meet your restricted specifications.

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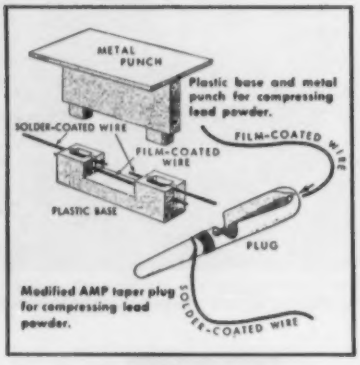
the LEAD newsletter

Only the imagination seems to limit the modern uses for lead and its compounds. This versatile material – well known to the ancient world – is finding hundreds of new uses today. Lead has many truly unique qualities that recommend it for use in applications that range from fine china to atomic rockets. Here are a few of the important jobs Lead is doing today – and the reason why Lead was selected.

Livelier Colors For Spandrelite

Lead-bearing glass color enamels are an important factor in the brilliant color palette of Pittsburgh Plate Glass Company's Spandrelite. This structural plate glass product is produced in a wide variety of jewel-like tones that range from pastels to chartones. These uniform colors are permanently fused into the glass and will not fade with time. Spandrelite is exceptionally corrosion-resistant, non-absorbent, stainproof, and is easily cleaned. These glass enamels are based on the excellent fluxing properties of lead compounds, which make possible livelier colors than any other flux. Lead also contributes low surface tension and low interfacial tension properties to the enamels on glass.



Superconductivity

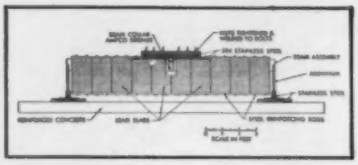
The superconductive phenomena of lead have not yet been fully exploited, but International Business Machine Corporation has successfully used lead for making superconducting connections to thin films of vapor-deposited metal in cryogenic circuits. Lead has a high critical field, and does not switch into the normal state by self-field when a gate strip of tin switches. It is economical and readily available in the purity and type desired . . . vaporizes easily so that flat film cryotrons can be made up by vacuum evaporation techniques. No heat and only moderate pressure are required when lead is used in powder form to make connections of the type used by IBM. Lead's normally high resistivity coupled with the superconducting transition makes lead and certain lead alloys very attractive and worth investigating.

Lead Braze Alloy Improves Quality, Lowers Cost in Joining Ceramic Metal Seals

Lead base solders are finding extensive use in electronic and metallurgical applications. The Research Laboratories of Sylvania Electric Products, Inc. recently demonstrated lead's versatility in joining by producing these ceramic-metal seals, useful up to working temperatures of about 300°C. The braze alloy can be used in either powder, sheet or wire form. No auxiliary flux is required to promote the bond, and a mechanically strong, completely hermetic seal is obtained. The lead braze is non-strippable, and has a higher breakdown strength that gives it both a quality as well as a cost advantage over other low cost commercial ceramic-metal sealing products.

Industrial Trucks Powered By Lead-Acid Batteries Prove Their Worth

Industrial trucks powered by lead-acid batteries are transporting all types of industrial products at comparable speeds – and doing it more economically – than other types of powered trucks. A recent analysis showed the following reductions in fleet operating and maintenance costs: 50% for fuel, 75% for maintenance parts and 60% for maintenance labor. Where 6 to 8 men were formerly needed to service and maintain the gas-powered fleet, the



equivalent of 3 men now handle the battery-powered fleet. Another example of lead's versatility and economy!

Lead Controls Vibration in "White Noise Room"

Lead – 592 slabs weighing 25 tons – is used in the "White Noise Room" of Minneapolis-Honeywell Regulator Company's Inertial Guidance Center as a damping mass to confine vibration and noise to the test area and to dissipate energy. "White Noise" is so called because it includes several frequencies of the noise spectrum, just as white light is a blend of several frequencies of the light spectrum. Here, researchers exactly duplicate the vibrations and mechanical noise produced by a missile or space ship in order to investigate the effects of vibration on the drift rate of gyros and accelerometers. In addition to minimizing vibration, lead is non-ferromagnetic, and eliminates any magnetic field disturbances that could interfere with other work in the area.

Lead Keeps Pace

Lead compounds are remarkably able to keep pace with changing technology. They are very much the subject of continued scientific attention, and L.I.A. researchers are constantly investigating new uses, new techniques to keep lead ahead.

If you would like information or technical assistance on a new product – or problem – where lead's unusual capabilities may be put to good use, please let us know. Write to: *Office of Technical Information, Lead Industries Association, 60 East 42nd Street, New York 17, N.Y.* 1071

LOOK AHEAD WITH LEAD

CLARE relays and stepping switches

One of five banks of Clare Type J Relays in P&W Numerical Control. At left, in cylindrical can, a Clare Type HG4 Mercury-wetted Contact Relay.

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PRATT & WHITNEY'S Numerical Control...

Pratt & Whitney's Numerical Control is a fully automatic, ultra-precise means of translating blueprint data into a series of machine positions. Applied to jig borers and other precision Pratt & Whitney machine tools, settings are made quickly, with high reliability to .0001" accuracy.

In operation, the Planning Engineer transfers to a Numerical Planning Chart all dimensional data from the blueprints which are necessary to determine the positions. Ordinary clerical help then punch these data into a tape. Machine positionings are then controlled by the tape or, when required, by a dial on the Operator's Console.

Here is what P&W's Mark H. Sluis has to say about the vital part played by Clare Relays and Stepping Switches:

"In the 4EA Numerically Controlled Jig Borer, punched-tape information is decoded by Clare Type J Relays and fed to a storage bank of 25 Clare Type 11 Stepping Switches. The selection of the proper storage switch is accomplished by a distributor—a Clare Type 26 Stepping Switch. In addition to storing the required command data for the slide positioning of this machine, logic circuitry comprises some 115 Clare Type J Relays.

"For ultra-reliability of the digit-selection circuitry, a dozen Clare Type HG4 four-pole Mercury-wetted Contact Relays are utilized.

"Through use of the Clare relays and stepping switches, our circuitry has increased in reliability, and a large contribution was made which enabled us to realize a 6:1 size reduction of the control system."

A Pratt & Whitney 4EA Numerically Controlled Jig Borer.

For complete information on Clare Relays and Stepping Switches contact C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P.O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

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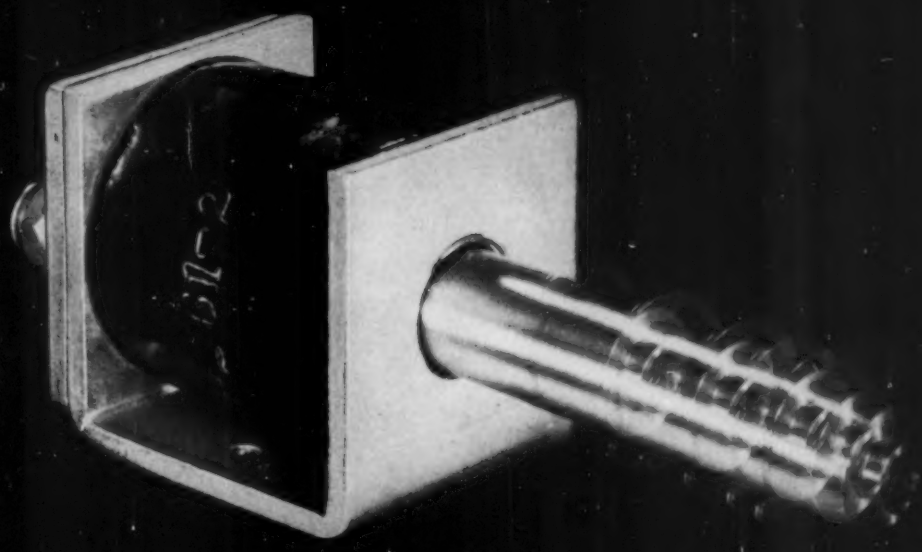

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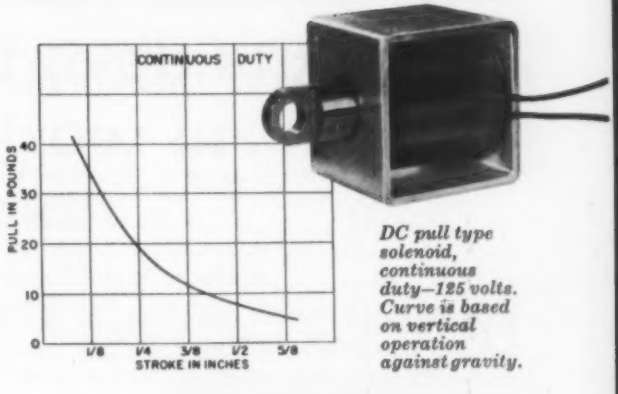

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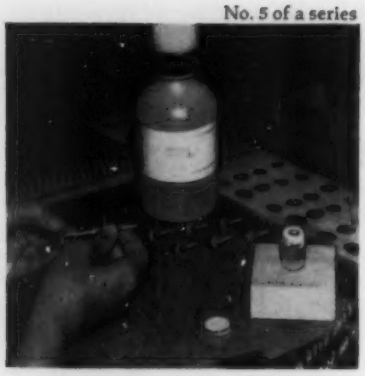

Eastman 910 Adhesive solves another production bottleneck

Electro-Voice, Inc., of Buchanan, Michigan, manufactures miniaturized phonograph cartridges, called "Power-Point," for high-fidelity audio systems.

The cartridge consists of a jewel-tipped ceramic transducer in a plastic boot, encased in nylon. Assembly is handled on a conveyorized production line and depends on rapid bonding of the components to obtain economical high-volume output.

The critical bonding problem is solved with Eastman 910 Adhesive.

Immediately following hand assembly, a drop of the adhesive is applied to the tiny components. *Moments later, a permanent bond is formed*... and the unit moves on, without delay.

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-ounce) send five dollars to Armstrong Cork Company, Industrial Adhesives Division, 9109 Irvin Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Division, Dept. P-9, Kingsport, Tenn.

Tangents...

Walking on Two Legs

We have previously mentioned (*PE* —Dec 15 '58, p 15; Apr 6 '59, p 26; May 4 '59, p 16) instances of Red Chinese ingenuity in overcoming immediate production problems by do-it-yourself methods. Many of these are incredibly primitive to our Western eyes. We have the machines and tools to do the jobs, yet England was forced to similar primitive methods at Dunkirk, we in the "temporary" prefabs we built for barracks and offices for the military. The Chinese are in effect taking a leaf from an old book of ours. That leaf may be somewhat soiled by forced labor—although they insist that everyone volunteers—but it has developed some quite ingenious solutions, according to latest reports.

At Wuhan Steel Works, for example, are banners saying "Do it the Yu Wen-hsiang way." In the plant, the man is known as "Master Yu," although he's only 36 and an electrical maintenance man with seven years of schooling—total. Apparently, his job was to maintain motor transport. He had 260 electric trucks to keep running, and his helpers were all unskilled men. On a given day, only about half the trucks were in working order; it took a week to recharge a battery, longer than that to repair a motor.

Master Yu knew the job was hopeless—so he added to his work by starting an unofficial school. He enlisted a friend who understood internal combustion engines. They prepared a syllabus for a course, compiled a mimeographed textbook, and started to teach, the friend handling the theory and Yu the practice. The shop was an off-hour classroom. Then the transit system took back 100 trucks, so only 160 were left. But Yu improved the service—tying together classwork and practical experience among his people to get the work out.

At first, there were only 11 apprentices. Then non-electricians began coming in. Finally, there were 60. Three months later, 42 sat for the exam and 38 were certificated as 3rd-class technicians—up two grades in a scale of eight from their previous jobs. Now similar classes are in session all over Hupeh province—some 250 teaching 10,000 people in the Wuhan Steel Works alone.

All sorts of factors enter here, the first two familiar: shortage of teachers, lack of facilities, 600,000,000 (or 400,000,000 according to Formosan figures—take your choice) people mostly untrained technically, a desire to learn, no union limitations, political and governmental pressures, etc. But the essential fact is that this is the "do-it-yourself" philosophy in practice. The Chinese call it "walking on two legs"—one leg aimed at long-term development, the other at immediate needs (with whatever is available).

Here are some other examples of the two-leg philosophy: In 1958, construction proceeded on 94 main-line railroads. Some 2300 km (1438 miles) of rail were laid, some of it to three previously unreached provincial capitals. Earthmoving was completed —mostly by hand—for 3000 km (1875 miles) more. Four bridges were started. Trial production began on electric and 4000-hp diesel locomotives. Locomotive production went up 100%, rolling-stock output 60%. Operational efficiency was stepped up to help haul the 22,800 more tons per day of summer foodstuffs, the doubled steel output, the new trucks to

(Continued on page 140)

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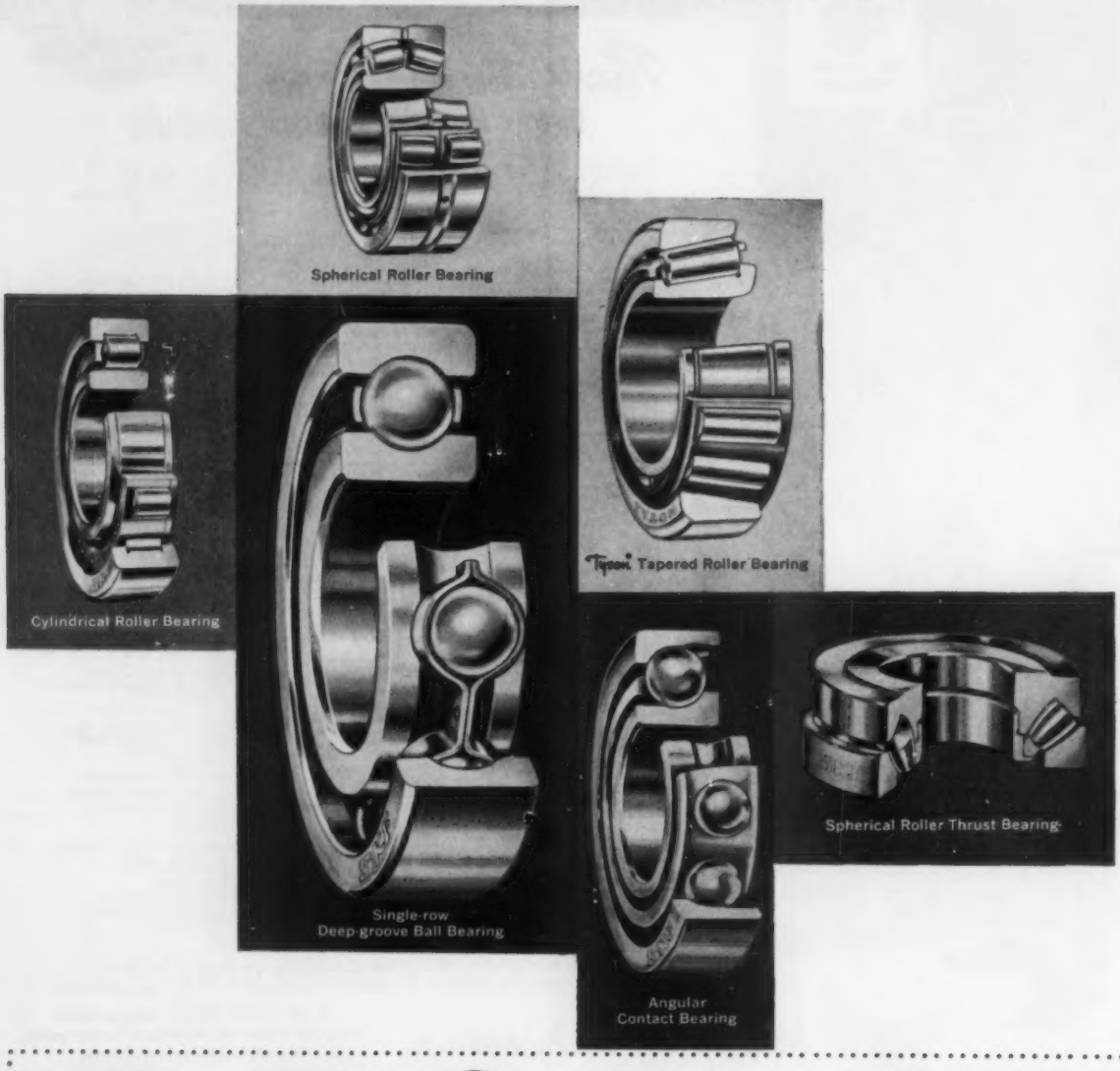

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For full information, write THIOKOL at address below.

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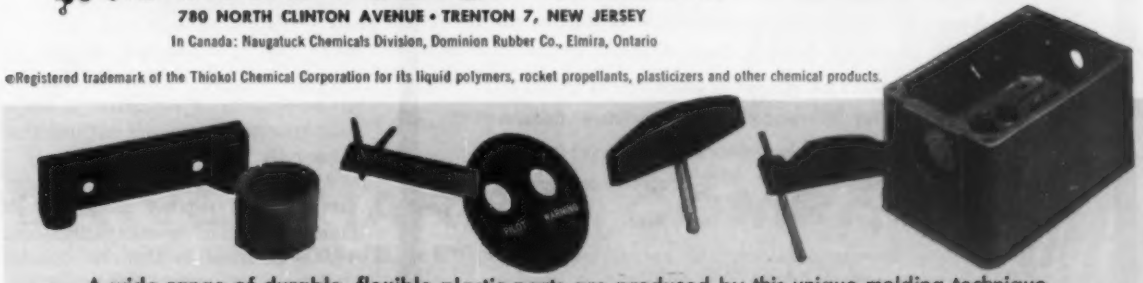

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PURPOSES

In addition to stimulating public knowledge in the industrial advancement of miniaturization, the MA 59 competition promotes national recognition of award winning companies, individuals, or organizations.

JUDGING OF ENTRIES

Entries will be judged by an independent committee of members of the electronics, metalworking, research and publishing fields.

ENTRIES

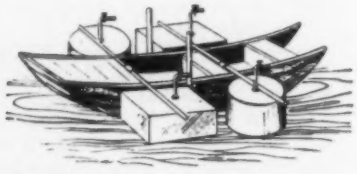
For a brochure giving criteria, upon which the entries are judged and other details of the competition, write Miniaturization Awards Committee, Box 604, Keene, N.H.

This brochure outlines the manner in which entries should be submitted and gives information on past winners. Because entries should be received by January 20, 1960, prospective entrants should secure the MA 1959 brochure as soon as possible.

remote construction sites, the coal for new factories. Yet the two main-trunk railroads (Peking-Canton and Tientsin-Nanking) are mainly single track! Obviously, heroic measures were needed.

Results include a kind of switch point without tapered rails, invented by a maintenance worker; a handshoe brake developed by five workers at an uncompleted hump siding; faster turn-around for cars (14 hr down to 8 at Fushin mine); local villagers helping on earth-moving, track-laying and double-tracking near their villages; cast-iron rails(!), home-made cars and even trucks acting as locomotives on spur lines. (Some 10,000 km—6200 miles—of spurs are planned.) In one case on the Pekin-Canton line, 200,000 peasants and workers double-tracked 320 km (200 mi) of the line in 4 mo, as compared with 18 mo for 174 km (109 miles) a year or two ago with workers alone. And the peasants thus acquire added skills.

Or in the power field: In Fuyang county, there is no coal or wood. So methane produced from ditches, stagnant water, manure pits and fermenting organic matter now totals 680,000 cu m per day, enough for 4/5 of the local population of 1.2 million. The main source is natural fermentation in manure pits, ditches and ponds. On ponds, the gas is collected by bell cans slung outboard of a rowboat. The bottom mud is stirred up by a rake, and



Methane collector for a pond

the released gas bubbles up into the bells and thence to oilcloth storage tanks. One man can thus collect 8 to 12 cu m per hr, enough to generate 48,000 to 72,000 calories of heat or 40 to 60 kwhr of electricity. A really primitive gas generator—but one that apparently works . . .

More advanced is the artificial fermentation of organic matter. Brick tanks of 10 to 500-cu m capacity, some 48,000 of them in this one county, store farmyard manure principally, but

(Continued on page 144)

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Now several of these are supplied *exclusively vacuum melted;* others can be on specification. In all there are now over 132 D-H alloys available for electronic and electrical applications. If your alloy need cannot be satisfied by any of these, send us your specification and depend on it . . . Driver-Harris will produce it.

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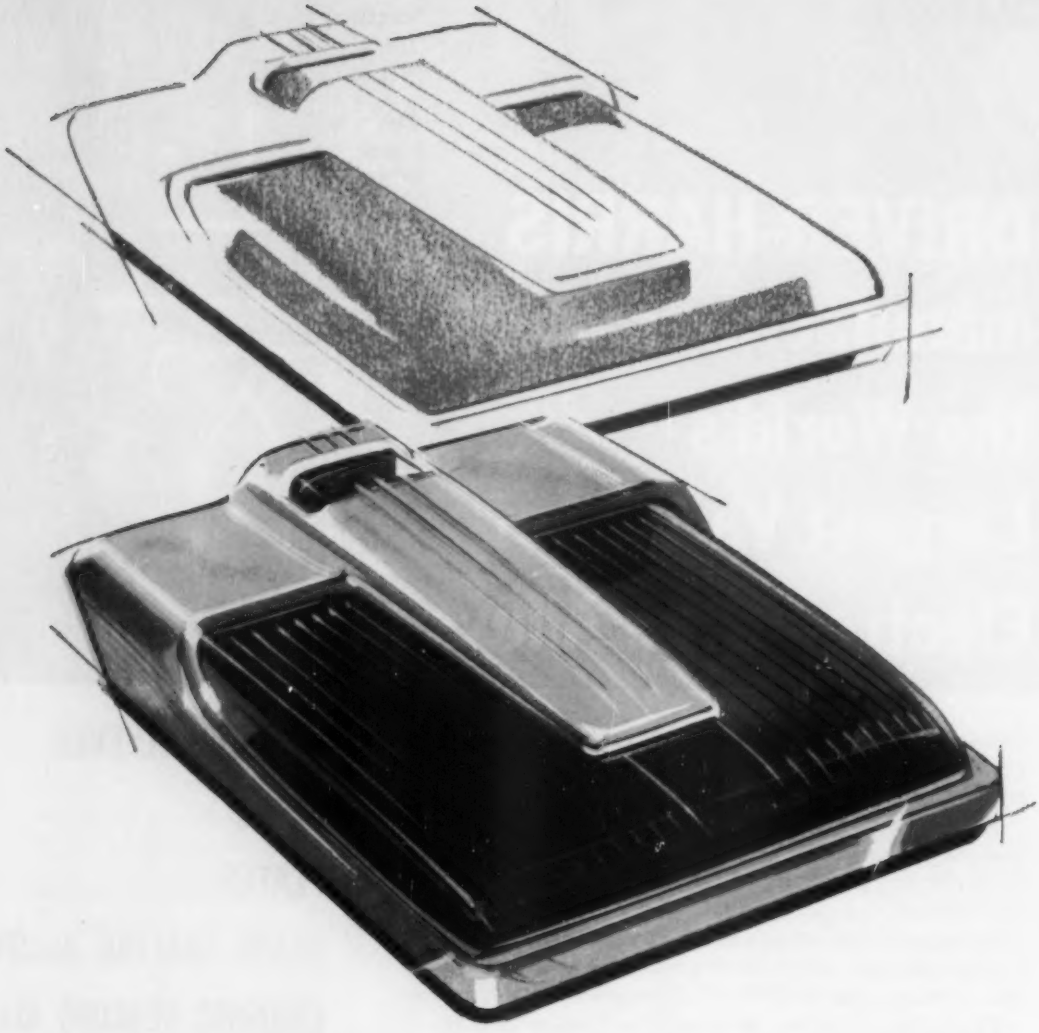
DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

CIRCLE NO. 141 READER SERVICE CARD 141



FIRESTONE SWINGS SALES YOUR WAY WITH *fashionized* ALUMINUM PARTS

Call on Firestone's fabricating and finishing abilities in colorful, low-cost mass-produced parts and trim for home appliances.

Call on the brightest brightwork in the business to catch the busy shopper's eye! Whatever your product-planning —a new look for an old line or wholly new innovation— call on versatile, low-cost aluminum parts and trim, formed and *Fashionized*® by Firestone.

Call on Fashionized Aluminum, and on Firestone's more than fifty years of metal-forming experience. Call, too, on the production capacities and competitive prices that Firestone's automated anodizing line can give you. Your inquiries and inspections are cordially invited. Write, phone or wire today.

FIRESTONE FASHIONIZED ALUMINUM
FIRESTONE STEEL PRODUCTS COMPANY, AKRON 1, OHIO

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

Frankly, we hope you're a fusspot. If you are fussy about the way you work, and proud of it, we think you'll enjoy knowing about three K&E items which reduce the effort required to get pin-neat results. Our first suggestion is . . .

A Better "Mattress" for Your Drawing Board

For effortless drafting, a good board cover is about as important as a good mattress is for sound sleep. Which is why so many draftsmen swear by LAMINENE® (N 70), the only *laminated* board cover material made. An exclusive, patented K&E process gives LAMINENE several very practical advantages over plastic coated papers. You can stretch it, drumhead-tight, over your board. All you do is wet the back, then secure the ends by taping or stapling to the underside of the board. After drying, LAMINENE grips the board as if cemented – there's no rippling, no stretching with the weather, no slack to take up. Its "drafting feel" is perfect: just the right balance of firmness and resiliency. LAMINENE'S non-glare surface makes it easier on the eyes, too, even under fluorescent lighting. You can expect to leave the board feeling fresher, even after a long day.

What's more, LAMINENE won't crack or scar like a plastic coating. Its laminated film surface is flexible, and stays that way – no crevices form to pick up workaday grime. It's easier to clean, too. A little soap and water is all it takes to keep LAMINENE looking like new.

LAMINENE is available in White or Eye-Ease Green; plain or with 4 x 4, 8 x 8 and 10 x 10 grids to the inch, which act as permanent two-way tracing guides. A free sample can be yours in a few days if you write us today. If you've never tried a laminated board cover, we promise you a new experience!

Stickers With Delayed Action

Want to eliminate a time-consuming chore? You can cut down on tedious repetitive lettering by having title blocks, specifications, and other symbols or legends printed

– clearly and sharply – on DULSEAL™ (74). This tissue-thin film has a delayed-action adhesive on the back, and a dull-finish face for easy writing or printing. Stickers made of Dulseal can be firmly positioned–and re-positioned hours later, just as firmly. The adhesive takes 24 hours to set. Once it does set, a permanent bond is formed with the paper or cloth beneath. Dulseal is chemically stable, and the adhesive will not bleed, even in hot copying machines.

Repeated erasures on Dulseal will not affect its "take." Produced by an exclusive process, the "tooth" is *built into* the surface. Transparent and low in reflectivity, Dulseal stickers will not affect the transparency or printing speed of your drafting medium. K&E supplies Dulseal in sheets, rolls (printed to your specifications if you wish), and as a mending tape in a handy dispenser. Try a sample, on us!

3 To Keep Clean

Best way to keep your tracings clean: don't let them get dirty. A mighty easy way to achieve this is to sprinkle the tracing lightly with gum eraser particles, while working. Then, triangles, T-squares, and scales stay clean, and clean the surface *automatically*, as they are moved back and forth. The particles will not dry out or harden – they contain no grit or abrasives. They'll actually improve the ink taking qualities of your drafting surface.

For this purpose, K&E supplies cleaning particles put up in three different ways. We think the new plastic squeeze-bottle (3036C) is the handiest of all. The shaker-top can (3036) has also been a drafting-room favorite for some time. And, for double-duty cleaning, we suggest the ABC Dry-Clean Pad™ (3037), which holds slightly coarser granules that sift through soft mesh. The ABC Pad also comes in handy for wiping a complete tracing after it is finished, or for preparing certain surfaces for ink work. Or for an overall pre-cleaning, since the best way to insure clean tracings is never to let soil build up.

The proverbial ounce of prevention is worth the traditional pound of cure!

These K&E products, and others that can make life easier for you, are available from your nearby K&E dealer. See him soon . . . or send us the coupon below for further information and samples.

KEUFFEL & ESSER CO., Dept. PE-9, Hoboken, N. J.

Please send me samples of LAMINENE® Drawing Board Surface Material, and DULSEAL™ Tape . . . plus information on K&E cleaning powders.

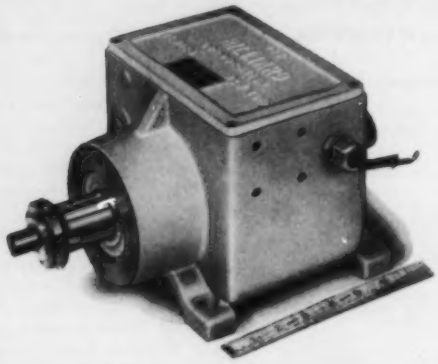
Name & Title_____

Company & Address_____

_____

3002

HILLIARD'S *New* "I.D.U."



A complete, packaged unit that gives you precise control of intermittent motion from a constant rotary power source!

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

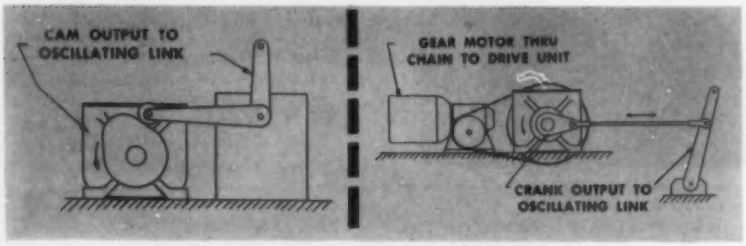
A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source of power.

HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms to control it.

"I.D.U." features highly flexible control—manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U"



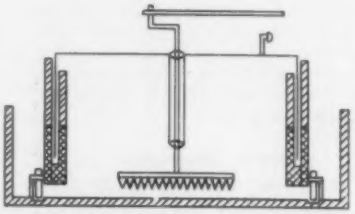
Basic Unit Price $289.00

Optional accessories extra

The HILLIARD Corporation

W. FOURTH ST. ELMIRA, NEW YORK

also rice and wheat straw, bran, dried leaves, grass and other refuse. It is mixed in a ratio of 3:5 with water; gas starts to form in 3 to 5 days. Stirring, as shown in the diagram, causes the gas to rise, and it is piped off through the tank (really a gasometer) top. Under normal weather conditions, every cu m of sludge produces 0.212 cu m of gas per day—about enough to produce 1 kwhr of electricity. Yield is thus over four times the 0.05 cu m of gas produced per cu m of pond sludge.



Artificial-fermentation methane generator

Nearly a third of the families in the county have their own crude gasometers. A large earthenware jar is the sludge tank, with a smaller one inverted inside as the collecting bell. For now, each of the 220,000 households is trying to save a kilogram a month of kerosene (formerly used for lighting) and 5 kg of straw per day for cooking, so the latter can be processed instead for fodder and fertilizer.

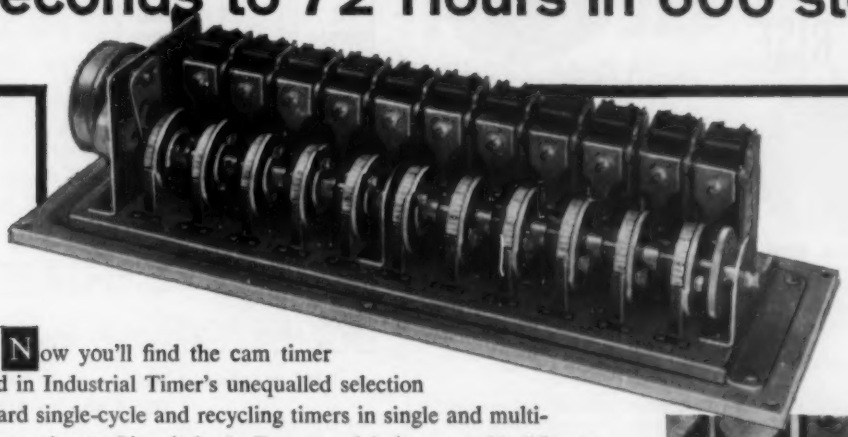
There are large-scale, more conventional gas producers too, both built and under construction, but these represent the slower, long-term, development "leg." Besides, the 320 farm co-ops each built such a tank, but not one of them worked, for three main reasons: (1) To cut costs, tanks were sunk in the ground, so low temperatures reduced fermentation. (2) Stirrers were omitted. (3) Tanks had fixed covers, not floating tops, so generated gas escaped through the walls.

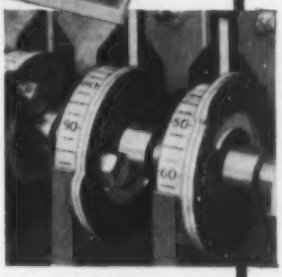
These have been rebuilt to correct the design errors and are now producing gas, but the original errors created a skepticism that led people instead to individual gas producers. Taught by chemistry teachers, they built their own, using auto inner tubes, basketball bladders, oilcloth bags, and even cloth bags coated with a bean flour and lime mixture as collectors, with reeds, bamboo or animal intestines to

(Continued on page 147)

THE WIDEST RANGE OF CAM TIMERS AND TIME CYCLES

2/3 Seconds to 72 Hours in 600 steps





Now you'll find the cam timer you need in Industrial Timer's unequalled selection of standard single-cycle and recycling timers in single and multi-switch types (up to 50 switches). Every model gives you 50 different overall time cycles, ranging from its lowest cycle up to 9 times that cycle. And standard cam construction lets you adjust ON and OFF periods from 2% to 98% of the total time cycle. Here is unsurpassed flexibility in cam timer selection and function.

If you don't find the timer you want in this unmatched range (a highly unlikely possibility), Industrial Timer's unique Timer Kit will help provide the exact timer you need at low cost. With this kit you can design your own prototype, and since the kit components are standard in our line we can reproduce your prototype—in quantity—*at no extra cost.*

For fast delivery on a standard or special Cam Timer check first with Industrial Timer. For more information ask for *Bulletin 200* Synchronous Motor Driven Cam Timers, *Bulletin 201* Multi-Cam Timer Kit, *Bulletin 202* Multi-Cam Switching Devices.

Industrial Timer's complete line of timers also includes: Time Delay Timers, Interval Timers, Running Time Meters, and Programmers. Bulletins describing these are available on request.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

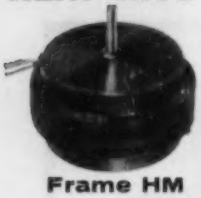
1409 McCARTER HIGHWAY, NEWARK 4, N. J.

CIRCLE NO. 145 READER SERVICE CARD 145

from **DALOHM**
better things in smaller packages

NEW BREAKTHROUGH IN HYSTERESIS MOTOR DESIGN GIVES LOWEST HEAT RISE

Frame HMD



Frame HM

Frame HMB

Priced competitively with any similar U. S. or foreign motor.

• Sub-Fractional • Lowest Cost • No Vibration • Synchronous

The new DALOHM hysteresis motor provides all the desirable characteristics of such motors, yet doesn't have the usual heat rise handicaps. Small and light-weight, its new pancake configuration is space saving.

Low cost is achieved by advanced design and production techniques. It is more economical to use because it uses a smaller capacitor than comparable motors.

Ideally suited for facsimile machines, Hi-Fi turntables, tape recorders, tele-metering and many other types of equipment where constant synchronous speed is essential.

- Low noise
- Maintains synchronous speed at rated load
- No vibrations or magnetic strays
- Reaches full RPM in one revolution
- Exceptionally low cost
- Will start at voltages as low as 100 volts, and will operate from 100-120 volts

RUNNING TORQUE: 1.9 in./oz. to 28 in./oz.

VOLTAGE: 115 V., 60 c.p.s.

SPEED: 1800 RPM (variable with frequency)

HORSEPOWER: 1/20th to 1/300th

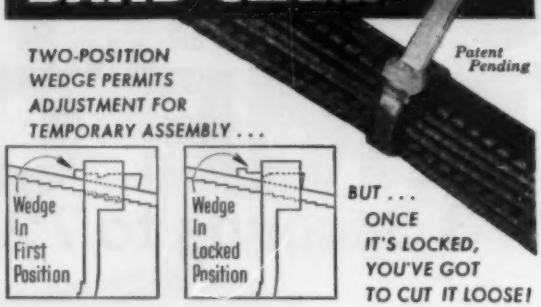
Write for Bulletin R-80

SPECIAL PROBLEMS?

You can depend on DALOHM, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

DALE PRODUCTS INC.
1372 28th Ave.
Columbus, Nebraska

new! *Weckesser* nylon
Wedge Lock
BAND CLAMP



Patent Pending

TWO-POSITION WEDGE PERMITS ADJUSTMENT FOR TEMPORARY ASSEMBLY . . .

BUT . . . ONCE IT'S LOCKED, YOU'VE GOT TO CUT IT LOOSE!

• Another Weckesser "first" • Just introduced at the I.R.E. Show • First *practical* band clamp that locks and holds permanently • Solid DuPont Zytel 101 (Nylon) • Easy assembly with screwdriver or forked tool—One size for cable diameters ⅛" to 1¾"

Send for free samples and bulletin

Manufacturers of Nylon, Teflon and Ethocel Cable Clamps, Molded Nylon Screws and Nuts, Nylon Threaded Rod and Washers.

Weckesser COMPANY
5705 Northwest Highway • Chicago 46, Ill.
CIRCLE NO. 206 READER SERVICE CARD

SECURITY PLASTICS, inc.
TAKES PLEASURE IN Announcing
A PLASTIC MOLDING METHOD — CAN SAVE YOU FROM 10% TO 20%

QUALITY NYLON MOLDED PARTS ARE NOW AVAILABLE WITHOUT THE USUAL HIGH MOLD COSTS. AT SECURITY, MEN WHO KNOW YOUR PROBLEMS HAVE COME UP WITH THE SOLUTION THAT MAKES POSSIBLE 7 TO 10 DAY DELIVERY OF MOST PRODUCTION SAMPLES OF NYLON MOLDED PARTS, ECONOMICALLY PRICED.

LET US PROVE OUR CLAIMS. SEND US YOUR PARTS DRAWINGS FOR QUOTATION.

HELPING TO MOLD THE FUTURE ...
SECURITY PLASTICS, inc.
4295 E. 11th Ave. Hialeah, Fla.
CIRCLE NO. 207 READER SERVICE CARD

replace scarce piping. Lamps were at first imported, but a local model was developed at one-eighth the price. Since then, some metal parts have been replaced by clay or wood, and the relatively expensive asbestos mantle by one made of cotton yarn treated with a cheap paste. The latter was developed by a local female Edison, who tried 350 combinations before she hit on the right one.

"Methane briquettes" were developed by another housewife. She dried a mixture of gaseous pond mud, wheat bran and salt. Some 6000 shops are now producing these; a 1-kg briquette will produce about as much heat as 0.6 kg of coal, for an eighth as much cost.

To take care of cold-weather production of gas, tanks are covered with mat sheds and provided with waste heat from local workshops or fermentation of straw or organic matter.

In the past year, methane has become almost a universal heat source. Of 5100 public dining rooms, 4700 cook with it. Six stations generate electric power and enough more are building to bring capacity to 40,000 kw by late 1961. This should light all villages (scattered homes will still use methane), and power 80% of co-op farm machinery.

These are not methods to be advocated anywhere but in a very primitive economy. But they are interesting examples of what can be done when the drive and will are there. How much more we could do, with our technological advantages! —EJT

"Your five years with us is not going to go unrewarded, Harris. Tomorrow you get a board by the window."

See with Safety

UNDER PRESSURE WITH THE PRESSURE

SIGHT GLASS AND MOUNTING

The rupture of sight glasses cannot be risked in the handling of expensive, inflammable or dangerous liquids. The PresSure sight glass, with a double safety factor of 10-plus, i.e., a 300 lb. PresSure sight glass will withstand 3000 PSI, opens a greater range of applications for chemical, pharmaceutical, aeronautical, petroleum, food processing, and many other industries. PresSure can be used on new or present equipment; only one mechanical operation required for installation.

Write for descriptive folder giving full information

PRESSURE PRODUCTS CO., INC.

DEP'T. 13, P. O. BOX 424, CHARLESTON, W. VA.

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A HANDFUL OF POWER

DOWTY Pressure Balanced HYDRAULIC GEAR PUMPS

Pressures to 2500 PSI • Outputs from 1/2-60 GPM

Shown here is our Model GP2-85 which will deliver 18 GPM at pressures to 2000 PSI. Volumetric efficiency exceeds 95% throughout the operating range. Fully pressurized lubrication independent of discharge pressure. 14 other sizes available.

Berry Hydraulics

A Division of Oliver Tyrone Corp.

MAIL FOR COMPLETE DATA

Berry Hydraulics
2226 Oliver Building
Pittsburgh 22, Pa.

Name_____

Company_____

Address_____

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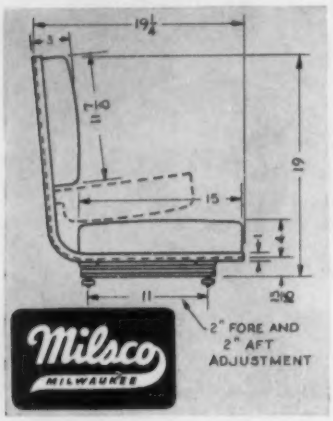
Milsco Cushion Seats Custom Designed and Engineered

Outstanding Example Is Smartly Styled "Thrift-King" Seat; Specified And Favored In Every Field of Mobile Equipment

● From out of a complete line of over twenty basic models comes this versatile unit in what has been described as probably the nation's greatest seating value . . . giving you an unequalled composite of quality with economy.



Over-all dimensions showing relative position of folding backrest.

Featured in the "Thrift-King" Seat is a wide selection of highest quality coverings and eye-styled color combinations. With the almost limitless product development possibilities this provides, your specific seat requirements will be met with Milsco's rare fusion of reality and individuality. No other approach to your problems will assure you of such complete satisfaction throughout every department. This, as well as other Milsco Seats, is available with or without the practically-designed pedestals or risers, for multi-positions and uses. Cushions are heavily padded with several inches of foam rubber for more durable service and operator ease. Other important advantages include such sales-pluses as: exceptionally sturdy, welded angle steel frame, and comfort-curved backrest with optional features for folding convenience.

Pedestal assembly available, with or without fore and aft adjustment.

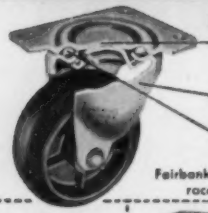
For illustrated catalog sheet Number 104, which gives a detailed description of the "Thrift-King" Seat, and for further information on other cushion and contour seating, write, or call

MILSCO MANUFACTURING COMPANY

2738 North 33rd Street • Milwaukee 45, Wisconsin • Phone HIlltop 4-6030

CIRCLE NO. 209 READER SERVICE CARD

ACHIEVEMENT
IN CASTER DESIGN
FAIRBANKS
"LOCKWELD" Swivel Casters—Without King-Pin



CHECK these unmatched advantages:

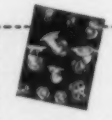
- No King-Pin. Patented "LOCKWELD" construction eliminates the major cause of caster failures.
- Patented leg designs — disperses shocks and overloads.
- Larger raceways and ball bearings — for faster, easier swiveling.

Fairbanks Series "23" double ball race swivel casters, 3" to 8".

Fairbanks Series "21" single ball race swivel casters, 2" to 3".

Fairbanks Heavy Duty Series "27" double race swivel casters

Fairbanks Series "500" Vulcanized Rubber Tired Wheels.



YOURS ON REQUEST: Casters and wheels catalog complete with specifications

Order Fairbanks products through your local distributor who is always ready to serve you.

THE **Fairbanks** COMPANY

393 Lafayette Street, New York 3, New York

Branches: New York 3 • Boston 10 • Pittsburgh 22 • Rome, Ga.

Valves, • Truck • Casters • Wheels • Dart & "PIC" Unions

Eliminate "high-cost specials" USE ARENS STANDARD-DESIGNS

See us first . . . and you will probably find the control you are looking for. Save the time and expense of having a special remote control designed, because one of Arens' 44 (and growing all the time) standard-designs will probably fulfill your requirements. But if not, our engineering and research department will be pleased to work with you on special controls for your application. Write us your requirements.

For information on illustrated models, please circle readers' service number.

ARENS CONTROLS, INC.

2029 Greenleaf Street, Evanston, Illinois

CIRCLE NO. 148 READER SERVICE CARD

CIRCLE NO. 210 READER SERVICE CARD

DESIGN ABSTRACTS

Lubricants and Friction

Cases where surface-active lubricants increase rather than decrease wear are described and explanation based on chemical interactions is given. Experimental setup and procedure are described. Lubricants used in study were transformer oil containing stearic acid and water with soap containing 72% sodium oleate. Results of friction tests are included, based on time to failure of wire specimens and by weight loss of pulleys in contract with wire specimens.

"Effect of Lubricants on Process of Friction," V D Kuzinetsov and others, Transactions of Akadimiya Nauk, 1956, Vol 109, No. 1, USSR. Translation available from Henry Brutcher, PO Box 157, Altadena, Calif.

Mechanism of Thermal Fatigue

Mechanics of thermal fatigue (sometimes called "fire cracking") are described and equipment and procedure used for experimental verification discussed. Importance of proper design and the selection of alloys combining high hot strength with low thermal expansion coefficients is pointed out.

"The Mechanism of Thermal Fatigue," H S Avery, American Brake Shoe Co. Metal Progress, Aug 1959, 7301 Euclid Ave, Cleveland 3.

Determining Weld Size

Various types of welds are discussed as well as the kinds of loads frequently imposed on them. Standard formulas to find force exerted on a weld are included, as well as a planned procedure for applying to specific design problems. Curves, tables and nomograms are included.

"Practical Approach to Determine Weld Size," O W Blodgett, Lincoln Electric Co. Welding Journal, Aug 1959, 33 W 39 St, New York 18.

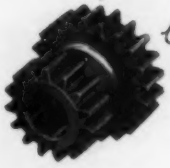
Engineering in the Evolution of Products

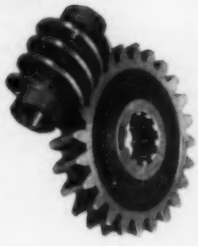
Analysis of the effects of vesting various sections of a manufacturing organization with responsibility for the initiation and development of new products is made and reasons for placing it in the hands of the research and engineering groups are given. Working relationships between research, engineering and industrial design person-

(Continued on page 151)

GEARS to drive newest machines...

produced by





EFFICIENTLY, ECONOMICALLY

FAIRFIELD

Getting into production on new models and new machines often calls for quick action to meet desired time schedules. FAIRFIELD CAN HELP YOU!

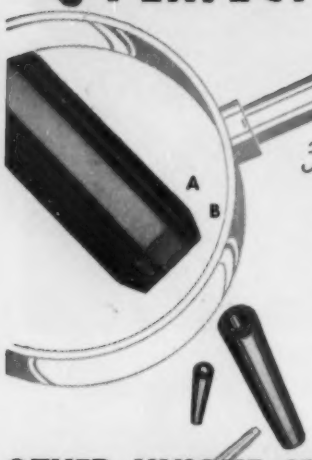
As one of America's largest independent producers of GEARS and DIFFERENTIALS, Fairfield's facilities are complete. You get the benefits of newest high capacity machines coupled with regular big volume output in an ultra-modern plant designed exclusively for producing fine gears EFFICIENTLY, ECONOMICALLY. Check with Fairfield NOW on your gear requirements. *Call or write.* FAIRFIELD MANUFACTURING CO., 2305 S. Co[illegible]rd Rd., Lafayette, Indiana. Telephone 2-7353.

Gears and Differentials for FINE GEARS Made to Order for:

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

CIRCLE NO. 149 READER SERVICE CARD

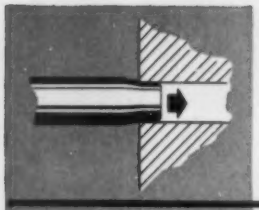
SPIROL - the spring PIN with PERFECT CHAMFER



For Smoother Insertion!

A. Smoothly rounded radius where chamfer meets shank eases insertion into hole. No sharp break to "bite" and resist insertion. B. Chamfer angle is precisely designed to offer minimum thrust resistance and maximum compression leverage.

OTHER UNIQUE SPIROL FEATURES



WIDER HOLE TOLERANCES

Both plus *and* minus hole tolerances are allowed because spiral construction permits greater flexibility in expansion and compression. The wider hole tolerances eliminate precision reaming requirements, reduce drilling rejects, cut costs.

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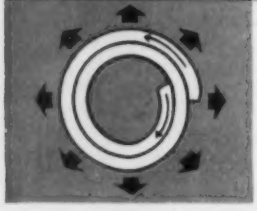
SPIROL is the only spring type pin available in these miniature diameters: 1/32" — .039" — 3/64" — .052". Unique spiral cross-section retains flexibility and strength in smallest sizes. Other standard sizes up to 1/2" diameter.



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High resistance to shock and vibration permits use of "medium duty" SPIROL pins in a wide variety of materials with wide range of bearing loads. Heavy and light duty SPIROL pins also available in stock.

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nel are also discussed. A standard procedure for product development is outlined, based on the author's suggestions for centralizing control in research and engineering.

"Engineering," W E Mahaffey, Whirlpool Corp. Presented at Conference on The Evolution of Products, Oct 26-29, 1958, sponsored by Center for Design Studies, Div of Institute for Contemporary Art, 230 The Fenway, Boston 15.

Style Manual for Technical Reports

Contents, organization and procedure for issuing company-wide guide for preparation of technical reports are discussed. Which types of style decisions should be compulsory and which left to the individual author's decision or personal writing style are also included.

"Building An Organization Style Manual for Technical Reports," Ethaline Cortelyou, Aerojet-General Corp. Presented at American Chemical Society Div of Chemical Literature Meeting, Sept 13-18. ACS, 1155-16 St, NW, Washington 6, DC.

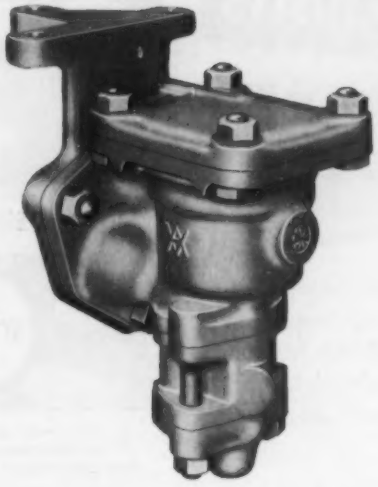
Why Should Engineers Vote?

How and why engineers should apply the engineering approach to political and civic affairs in their individual communities. Specific suggestions as to the forms participation by engineers might take are given.

"Why Should Engineers Vote?", J W Barker, Research Corp. Mechanical Engineering, Aug 1959, 29 W 39 St, New York 18.

". . . And, then, after you finish these, you'd better hurry home. Your house is on fire."

Typical Control Functions solved by AIR CIRCUITRY



● The H-5 RELAYAIR Valve, one of many Westinghouse Air Circuitry Components, is a pilot operated, directional control valve. It may be normally open or normally closed, depending upon port connections.

Various spring settings provide operating pressures from 3 to 150 psi. An easily removable pipe bracket permits removal of valve without disturbing pipe connections.

Envelope size: 7¾" x 7⅜" x 4⅜"
Maximum supply pressure 200 psi.

Typical Applications—In addition to the illustrated functions, this highly versatile valve has been and can be used in all conceivable types of air circuits. Some of these are as follows: cycling operations, safety interlocks, low pressure alarm signals, emergency cut-off of power, emergency brake applications, remote control station relays, sequence control timing, and many many others.

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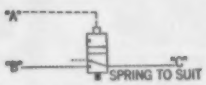
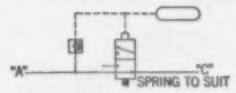
What is air circuitry?

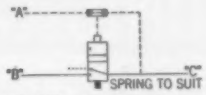
This is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise Air Circuitry is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.



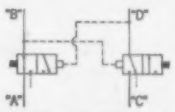
1. RELAY—To increase flow or pressure in an air circuit. An air signal directed to line "A" overcomes a spring opposed diaphragm to connect line "B" to line "C." Various spring values determine operating pressure.



2. TIME DELAY—To provide automatic power unloading. Air signal pressure in line "A" flows through the device to line "C" to perform specified operation. A check valve with choke and a volume provides a time delay by requiring a predetermined pressure be built up before line "C" is vented to atmosphere.



3. LOCK-UP—To provide a hold-in feature. Air signal in line "A" connects line "B" to line "C." Air from line "C," through a shuttle valve, holds this connection when signal air is vented.



4. CRISSCROSS INTERLOCK — To prevent energizing one line before another is vented. With lines "A" and "B" energized with air pressure, line "D" is vented to atmosphere. Line "D" cannot be energized until line "B" is vented. The converse is true when lines "C" and "D" are energized.

5. SEQUENCE INTERLOCK—To insure one function is performed before another is initiated. Line "A" must be energized to a predetermined pressure before line "B" can pass air to the next function.

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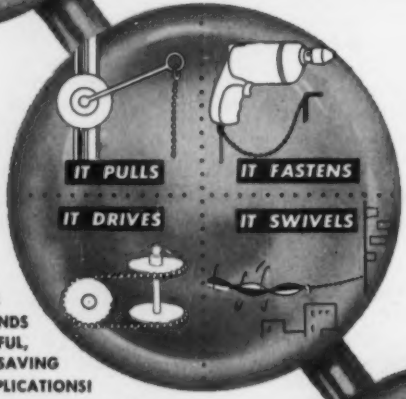

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NEW BOOKS

Wear, Friction at High Sliding Speeds

PB 131963. F M SAUER, Stamford Research Institute. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10, 54 pp. $1.75.

An experimental program and theoretical study were conducted to gather data on high-speed wear and friction, and to determine wear mechanisms. Twenty-one test runs were made using Type 304 stainless-steel sliders, and two were made using unalloyed molybdenum. Bearing pressures ranged from 160-1,600 psi, and sliding velocities were 600-790 fps. It was concluded that slider surface temperature increases from ambient to melting during transient phase. It was also concluded that a molten film exists at interface between slider and rail during steady state phase. Consequently, modybdenum—a high-melting-point and high-thermal-diffusivity metal—was tested, and results showed an overall wear rate of $\frac{1}{10}$ that of stainless steel under the same conditions. Full title; "Fundamental Mechanism of Wear and Friction of Unlubricated Metallic Surfaces at High Sliding Speeds".

Engineering and Organization

EVERETT LAITALA, Professor of Industrial Engineering, Case Institute of Technology. Published by Richard D Irwin Inc, Hollywood, Ill. 6 x 9¼, 391 pp. $7.20.

This is essentially a college text for a course with about the same title. It covers everything from the philosophy and nature of engineering through organization and basic functions, and is rather general. A bibliography of additional reading is provided at end of each chapter, plus questions to be asked of the student.

Essentially, this is a compendium of information from a great many sources, some of them 10 or a dozen years old, so that its usefulness is primarily in the area of standard reference rather than up-to-the-minute information. Only one chapter is devoted specifically to the product-design function in the organization, but there are

(Continued on page 155)

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Clean oil is required for transmissions used in earth moving, mining and other heavy-duty off-highway equipment. Fuller Manufacturing Company, Kalamazoo, Michigan solved that problem by creating pressurized filtration and lubrication systems, which include Viking Pumps, as standard equipment on their transmissions.

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See Our Catalog in Sweet's Product Design File

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one-piece locknut . . . *with prevailing torque*

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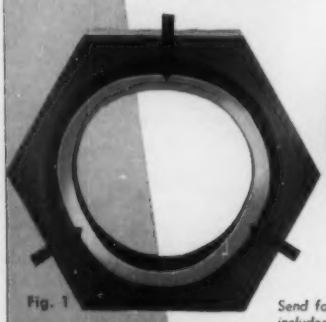

Fig. 1

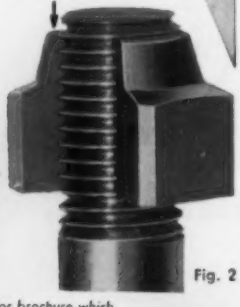

Fig. 2

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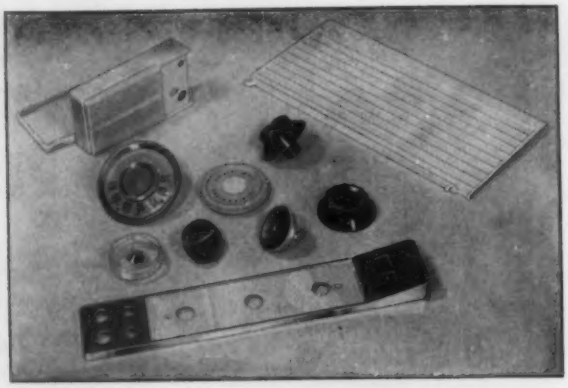

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other things of occasional interest such as definitions of engineering, factors to be considered in preparing job specifications for engineers, canons of ethics, and a statement of faith.

The Gentle Art of Mathematics

DAN PEDOE. Macmillan Co, 60 Fifth Ave, New York 11. 5½ x 8, 143 pp. $3.50.

This is somewhat more than a collection of mathematical puzzles and games, for the book describes, in a lively and readable fashion, some of the highlights of modern mathematics, including: chance and choice and the law of averages; extrasensory perception; logic and automatic thinking; topology and geometry; symmetry and series; rational and irrational numbers; and the problem of infinity.

There are also many amusing problems and applications of mathematics, such as how to take off your vest without taking your arms out of your jacket, and how to construct a surface with only one side.

Guided Missile Engineering

Edited by ALLEN E PUCKETT and SIMON RAMO. McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6 x 9, 497 pp. $10.

This book is an introduction to "system engineering" as employed in guided missile design. The chapters represent a survey of a number of the sciences important in guided missile design. Basic elements of these sciences are presented with emphasis on those aspects which bear on guided missile design. The various chapters

(Continued on page 157)

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Adhesives made by B.F.Goodrich will bond almost any materials you can name—joining them to themselves or each other. Sometimes, adhesive bonding is the only practical method of fastening. In other cases, adhesives often have special advantages—high strength, less weight, lower cost or greater freedom of design.

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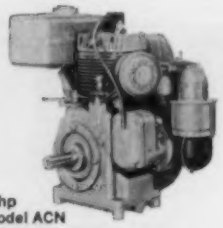
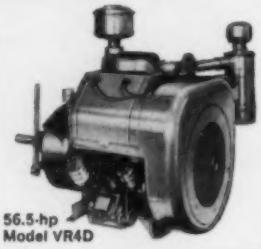


3-hp Model ACN



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Here's why: Wisconsin engines are precision-fitted to give the most hp-hours of service with the least care. They furnish fast-starting, smooth-firing power in sub-zero cold or in 140° F. heat — and respond with load-lugging power to ease your equipment through sudden shock loads.

Air-cooling eliminates up to 26 parts used on water-cooled engines. Your customers don't have to worry about freeze-ups, dry-ups, scaling — nor about power failure due to wear, rust, leakage, or failure to service water-cooled components.

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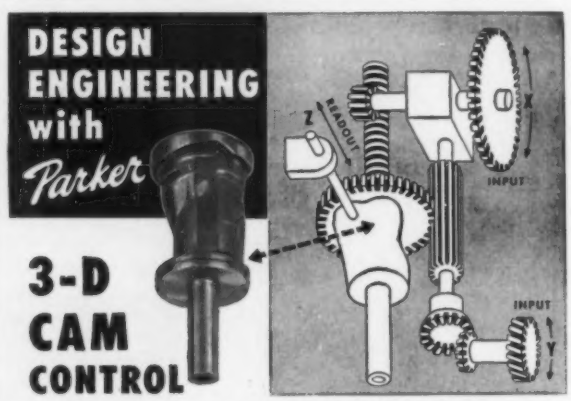

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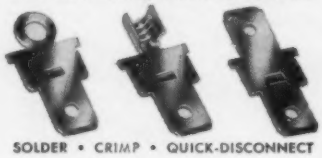

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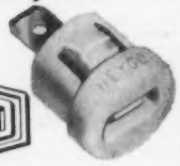

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are directed at the engineer or scientist who may have considerable skill in some other field, but little familiarity with the subject in question. The book is not a handbook of guided missile design but will help the engineer to appreciate the problems of his collaborators.

Kinematic Analysis of Mechanisms

JOSEPH EDWARD SHIGLEY, Associate Professor of Mechanical Engineering, Univ of Michigan. McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6 x 9, 351 pp. $7.75.

For both the student of engineering and the practicing engineer, this text gives a solid background in mechanism analysis. It stresses basic theory and builds strong methods of analysis.

Graphical and analytical methods are equally emphasized. The traditional graphical method is employed, and two analytical methods of vector analysis are included. All three methods are applied generally but in easy stages, to both the analysis and the synthesis of mechanisms.

Technical Calculus and Analysis

RICE and KNIGHT. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 6 x 9, 460 pp. $6.75.

Emphasis in this text is on elementary calculus as a mathematical tool for those planning to enter the production and construction areas of engineering technologies. The power and limitations of the techniques of elementary calculus are illustrated by specific industrial applications representative of various technologies.

The graphical approach is emphasized, and centroids and second moments are treated in detail. Concepts such as functions, functional notation, continuity, differentials, and limits are accorded a thorough discussion. The text includes an interesting chapter on statistics and probability.

High-Temperature Materials

HEHEMANN and AULT. John Wiley & Sons Inc. 440 Fourth Ave, New York 16. 6 x 9, 544 pp. $17.50.

Essential for research in high-temperature materials, this book is more

(Continued on page 159)

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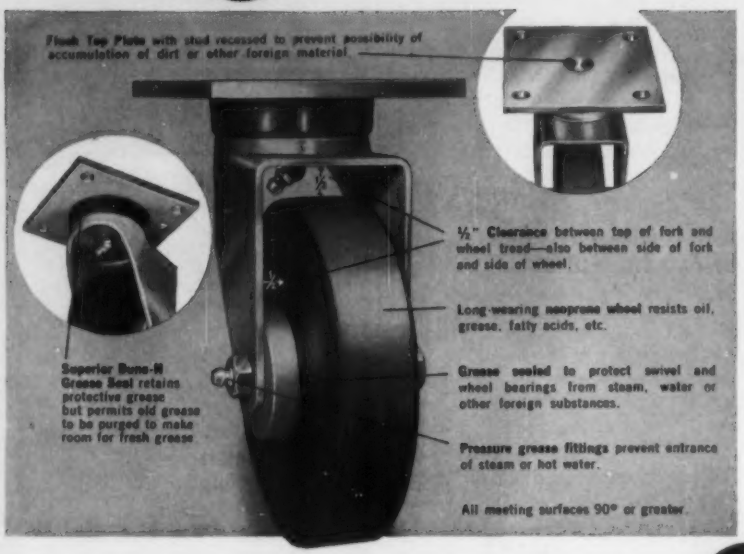
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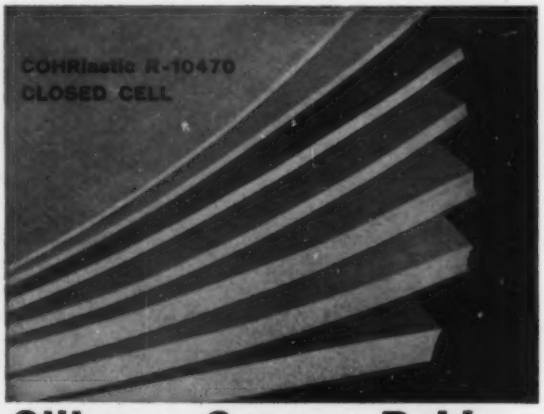

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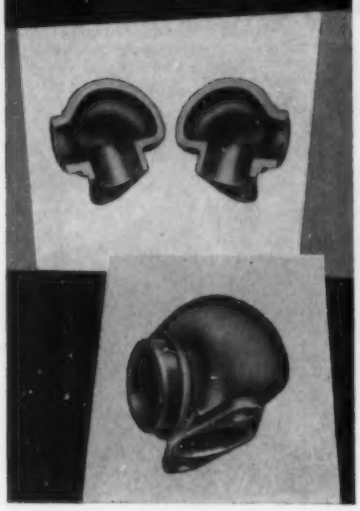

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up to date than any in its field of coverage. It presents the entire gamut of today's technology in materials for applications above 1500 F. Some of this information is from internal company reports and not available elsewhere.

It covers some of the fundamentals of high-temperature metallurgical reactions within the materials and how they might be used to develop new materials. And in addition to the usual type of plotting and tabulating high temperature tensile properties, it also gives very useful information on how to design shapes with the brittle cermets. This can be adapted to other designs where brittle materials must be used under tensile loading.

The book is very worthwhile if you can afford the price.

Bolt, Nut and Rivet Standards

Industrial Fasteners Institute, 1517 Terminal Tower, Cleveland 13. 6 x 9, 287 pp. $3.

This third edition now includes all current engineering standards, including those made since the 1952 edition. It is published as a guide for both manufacturers and users of industrial fasteners and brings together into one volume nationally recognized dimensional standards for general-purpose industrial fasteners. These include bolts, nuts, studs, screws (machine, cap, tapping, wood), washers, and rivets. There is also useful information on fastener specifications and standards, grade markings, locknut specifications, terminology, and unified screw thread standards.

Most of these standards were devel-

(Continued on page 161)

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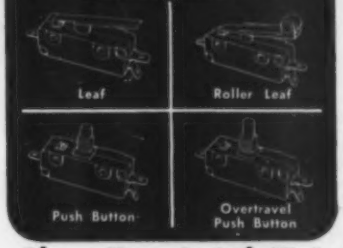

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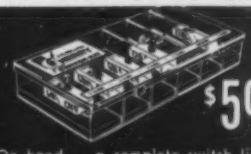

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There's another great service to our country's welfare of which these people are justly proud, too. For they are adding to America's Peace Power through the purchase of U. S. Savings Bonds on the Payroll Savings Plan. By regular purchase of Shares in America these thrifty people are reinforcing their own security and establishing current reserves for home-building, education and travel.

If your company already has the Payroll Savings Plan, make sure that every employee is actively encouraged to join. If you don't yet have the Plan, maybe now's the time to install it. For information and help, contact your State Savings Bonds Director. Or write to: Savings Bonds Division, U. S. Treasury Dept., Washington, D. C.

Shown here is **Arno Paegel**, at work with one of the great electric light and power companies of this country. Like so many thousands of his fellow craftsmen, Mr. Paegel is making regular use of his company Payroll Savings Plan to contribute to the Peace Power of America.

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New Books .....continued

oped over a long period of years through the standardizing procedures of the American Standards Assn. They were gathered, organized and published in this convenient handbook under the supervision of the Institute's Committee on Standards and Technical Practices.

Electrical Measurement Analysis

ERNEST FRANK. McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6 x 9, 443 pp. $8.75.

Methods of measurement in this textbook are classified into two major categories; null and deflection. Illustrations in each are developed in mathematical detail. Special attention is given to the ideas of measurement errors and their statistical treatment, and also to the compensation theorem largely ignored in previous works. Error-analysis techniques are emphasized in the treatment of ohmmeters, potentiometers and bridges. There is also an analysis of square-wave response of galvanometers from both a steady-state and transient point of view.

Among other important topics given in detail are: statistics and errors; fundamental force ideas; force and field energy; linear graphs as an analysis; d-c and a-c bridges including transfer functions. Answers to all problems are given at the end.

Impact of Research and Development on the Economy

Proceedings of Conference sponsored by National Science Foundation in May 1958. Superintendent of Documents, Government Printing Office, Washington 25, DC. 223 pp, 7 x 10⅛. $1.25.

This volume, entitled "Proceedings of a Conference on Research and Development and Its Impact on The Economy," was attended by more than 400 economists, scientists, and administrators from industry, government, universities and other nonprofit organizations. This audience heard papers and discussions by some of the best-known names in scientific, economic and industrial fields, including Slichter, Saulnier, Suits, Waterman and Killian.

Impact of research and development on selected industries was in-

(Continued on page 163)

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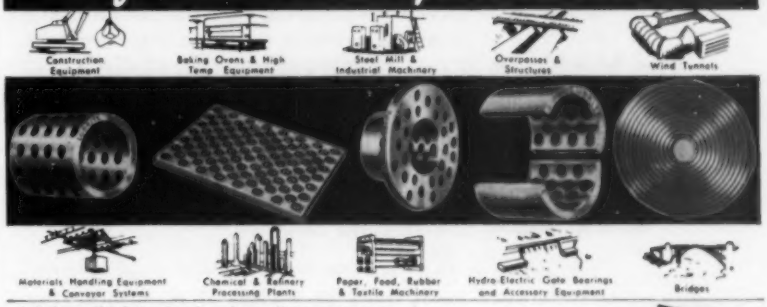
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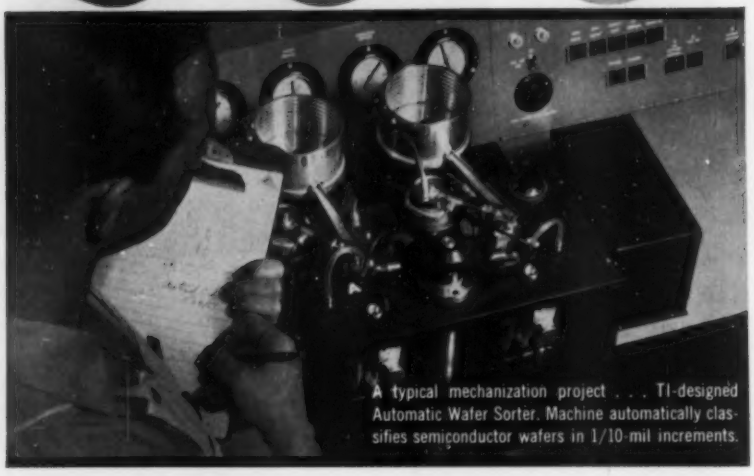

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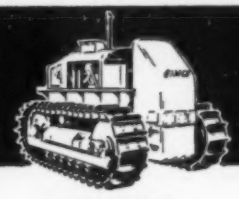

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vestigated as well as on the economy as a whole. Another panel discussed the opportunities for basic research in industry. Dr. Killian examined the organization and resources required for an adequate program of research and development, and its relationships to our kind of society. In the appendices are charts and curves on expenditures for R&D.

Other Books of Interest

Asbestos: Its Industrial Applications

D. V. Rosato. Reinhold Publishing Corp, 430 Park Ave, New York 22. 4¾ x 7¼, 214 pp, $5.75.

Includes information on properties, asbestos-cement products, and the use of asbestos for insulation, friction applications, textiles, packings.

The Structure of Metals: A Modern Conception

Lectures Delivered at Institution of Metallurgists Refresher Course, 1958. Interscience Publishers, Inc, 250 Fifth Ave, New York 1. 5 x 8¼, 118 pp, $4.

This collection of lectures sponsored by the English metallurgists organization includes papers on electron structure and theory and dislocations.

Environmental Requirements Guide for Electronic Component Parts

PB131423. Advisory Group on Electronic Parts and Advisory Group on Electron Tubes. Office of Technical Services, Dept of Commerce, Washington 25 DC. 8 x 10¼, 11 pp, 50¢.

Plastics Safety Handbook

Society of the Plastics Industry Inc, 250 Park Ave, New York 17. 5¾ x 8¾, 208 pp, $5.

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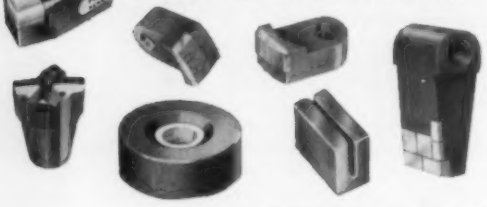
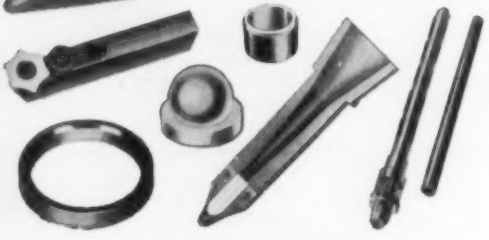


DEPENDABLE resistance to abrasion . . . for such component parts as spray nozzles, orifices, seal rings, bushings, pulverizing hammers, drawing and compacting dies, non-lubricated guides and various gripping jaw applications.

DEPENDABLE resistance to corrosion, cavitation and wear . . . vital to valving in oil well operations, hydraulic systems, parts for chemical processing equipment exposed to strong mineral acids, red fuming nitric acid and similar highly corrosive agents.



DEPENDABLE strength at high temperatures . . . needed for gas turbine components, sensing elements for jet stream thermostatic controls, parts to handle or process glass in semi-plastic state, flame burner tips, hot rod mill guides, tip wear rings for scarfing torches. (Kentanium*, a series of hard titanium carbide alloys, retains high strength for continuous operation at temperatures up to 2200°F and provides high stiffness/weight ratio.)

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Index of

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In This Issue

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD.

A

Accumulators 117
Adhesives.....52, 126-127, 132, 136, 155
Aluminum Alloys 87, 142

B

Bearings
- Ball 138
- Miniature 140
- Needle 123
- Roller.....4th Cover, 123, 138
- Self-Lubricating 161

Belts, Timing 94
Belts, V 18-19, 126-127
Beryllium 166
Blowers 107, 167
Bolts 106, 154
Boosters 117
Brakes
- Electric 53, 116

Brazing
- Alloys 170

Bushings 157

C

Cams 152, 156
Carbide Alloys 164
Casters 148, 158
Castings 92
Castings, Precision Investment....48, 159
Ceramics 125
Chains
- Bead 152
- Conveyor 109, 150
- Roller 109
- Silent 11

Chemical Treatments 66
Clad Metals 46
Clamps 146
Clips 64
Clips, Electrical 146
Closures 99
Clutches
- Electrical 53, 116
- Mechanical 28-29, 100

Coatings 58-59, 66, 104
Contactors 110-111
Contacts & Contact Materials..... 157
Controls
- Electrical 26, 101, 110-111
- Electronic 110-111
- Mechanical 148
- Pneumatic 113, 151

Cork Compositions 25
Cylinders
- Hydraulic 117, 119
- Pneumatic.....113, 117, 119, 151, 158

D

Die Castings 120, 161
Drafting
- Supplies 143

Drives
- Mechanical 144
- Variable Speed.....3rd Cover, 11, 23

Index of

PRODUCTS ADVERTISED

In This Issue

E

Engineering Services (see also Production Services) 122
Engines 156
Extrusions
Metallic 4

F

Fastening Methods 22, 62-63, 64, 106, 150, 163, 165, 168
Filters
Air 113, 137
Hydraulic 163
Film, Plastic 10
Flexible Couplings 49-50
Flux 170
Forgings 60

G

Gaskets 25
Gear Motors (see also Motor Reducers) 61, 153
Gears 16, 149, 169
Glass 147

H

Hose & Tubing 121
Hydraulic Fluids 135

L

Lead 130
Locks 165
Lubricants 135
Lubricating Equipment 137

M

Metal Forming 12-13
Moldings
Plastics (see Plastic Parts)
Rubber (see Rubber Parts)
Motor Starters 43-44
Motors, A-C
Fractional ..... 3rd Cover, 8-9, 31, 105, 150, 153
Integral 31, 43-44, 150, 153
Sub-Fractional 8-9, 114, 118, 146
Motors, D-C
Fractional ..... 3rd Cover, 8-9, 23, 31, 105, 153
Integral 23, 31, 43-44, 153
Sub-Fractional 8-9, 146

N

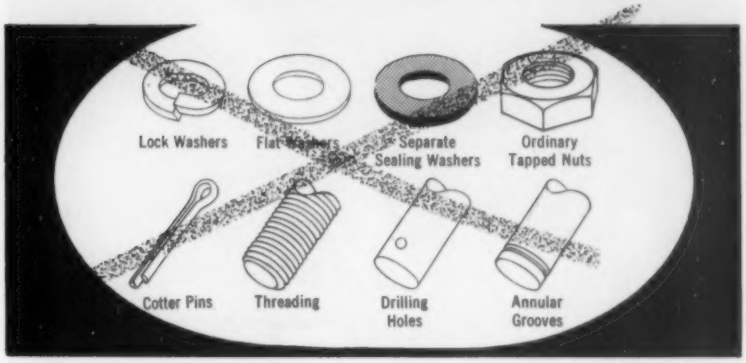
Nickel Alloys 2, 141
Nuts 22, 146, 154, 165

P

Packings 126-127
Phosphor Bronze 51
Pillow Blocks 24
Pins 150
Plastic Parts 112, 146, 152, 154

PALNUT® LOCK NUTS and FASTENERS *Eliminate*

one or more of these assembly parts or operations



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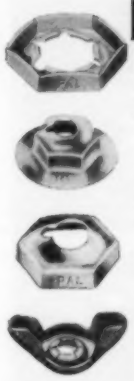

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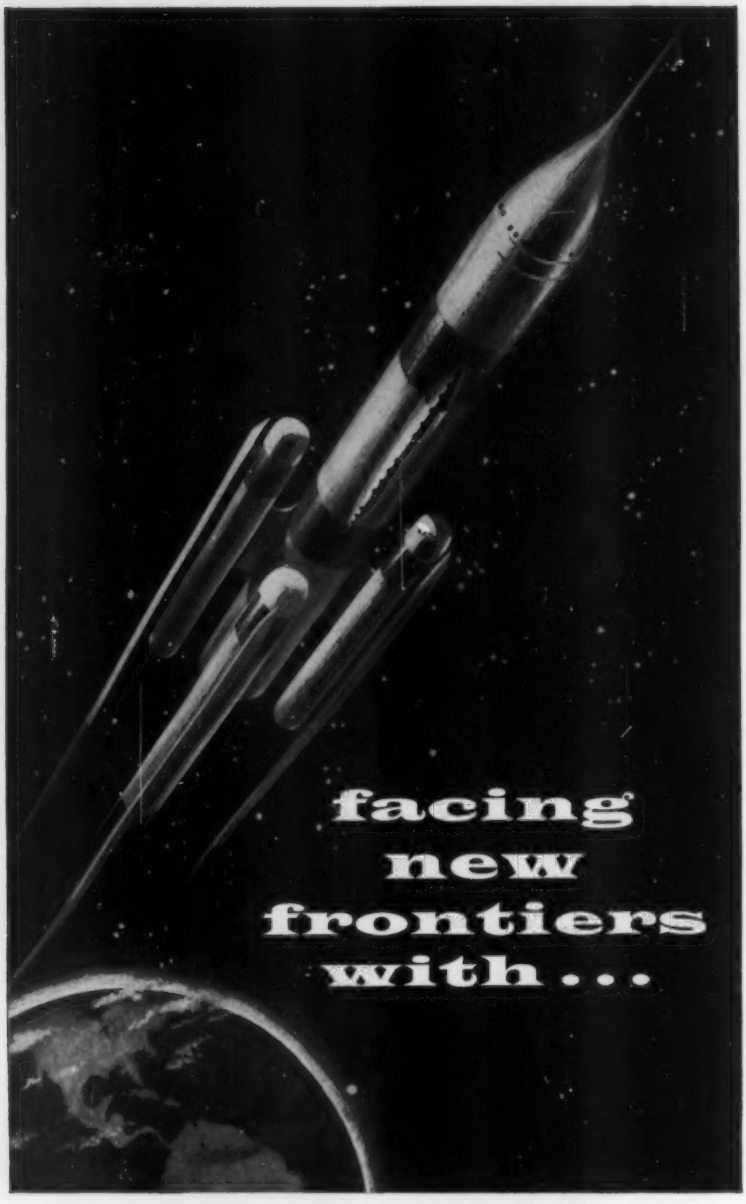

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Index of PRODUCTS ADVERTISED

In This Issue

Plastics 20-21, 47, 56-57, 102-103, 112, 115, 146
Precious Metal Alloys 141
Production Machines & Processes 163
Production Services (see also Engineering Services) 122
Pumps
Liquid 147, 153

R

Regulators
Pneumatic 113, 137
Relays 103, 110-111, 131
Reproduction Equipment 134
Reproduction Supplies 134, 143
Resins 20-21, 56-57
Retaining Rings 17
Rivets 22, 106, 163
Rods
Nonmetallic 115
Rubber 96, 139, 158
Rubber Parts 158

S

Screws 62-63, 146
Seals ..... 2nd Cover, 126-127
Seating Work Equipment 148
Silicones 33-34
Silver Alloys 170
Solenoids 124, 133
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) 22, 64, 159, 168
Speed Increasers & Reducers 61
Springs 6, 54-55, 108, 118
Sprockets 109
Strip, Metallic 129
Switches 101, 159

T

Testing Machines & Equipment 118
Thermostats 26, 30, 88
Timers 15, 101, 145
Tracing Cloth 156
Tubing
Flexible Metal 27
Seamless 4, 14
Welded 4

V

Valves
Air 1, 113, 151
Hydraulic 128
Solenoid 2

W

Weldments 89
Whiteprinting Equipment 134
Wire Cloth 32

Z

Zinc Coated Strips 129

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it as write but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

AllenAir Corp. 158
Allied Research Products, Inc. 66
Aluminum Co. of America 87
American Brass Co. 51
Anaconda Metal Hose Div., American Brass Co. 27
American Steel & Wire Div., U. S. Steel Corp. 54-55
Angier Adhesives Div., Interchemical Corp. 132
Arens Controls, Inc. 148
Armstrong Cork Co. 25
Arwood Precision Casting Corp. 48
Associated Spring Corp. 6
Auburn Mfg. Co. 152
Automatic Switch Co. 133

Babcock & Wilcox Co., Tubular Products Div. 4
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 60
Bead Chain Mfg. Co. 152
Berry Hydraulics Div., Oliver Tyrone Corp. 147
Beryllium Corp. 166
Bond Co., Charles 49-50
Boston Gear Works 109
Brevel Products Corp. 153
Browning Mfg. Co. 150

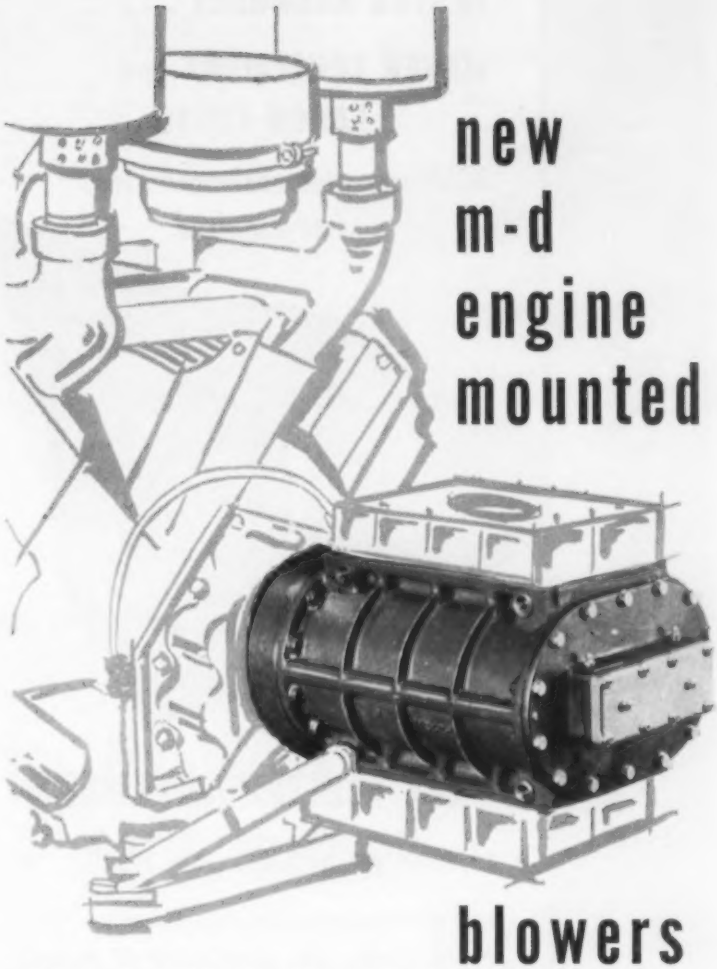
C. E. M. Co. 150
Cambridge Wire Cloth Co. 32
Chatillon & Sons, John 118
Cherry Electrical Products Corp. 159
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Clare & Co., C. P. 131
Commercial Shearing & Stamping Co. 12-13
Connecticut Hard Rubber Co. 158
Consolidated Molded Products Corp. 112
Controls Co. of America 101
Coors Porcelain Co. 125
Cutler-Hammer, Inc. 110-111

Dale Products, Inc. 146
Dayton Industrial Products Co., Div., Dayton Rubber Co. 18-19
Dodge Mfg. Corp. 24
Doerr Electric Corp. 150
Double A Products Co. 128
Dow Chemical Co. 20-21
Dow Corning Corp. 33-34
Driver-Harris Co. 141
du Pont de Nemours & Co., (Inc.), E. I., Film Dept. 10
Dynamatic Div., Eaton Mfg. Co. 53

Eastman Chemical Products Inc., Chemicals Div. 136
Eastman Chemical Products, Inc., Plastics Div. 47
Eonic, Inc. 152

Fairbanks Co. 148
Fairfield Mfg. Co. 149
Fenwal, Inc. 88
Filtros, Inc. 163
Firestone Steel Products Co., Div., Firestone Tire & Rubber Co. 142
Formsprag Co. 28-29

(Continued on p. 168)



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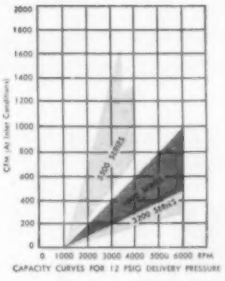

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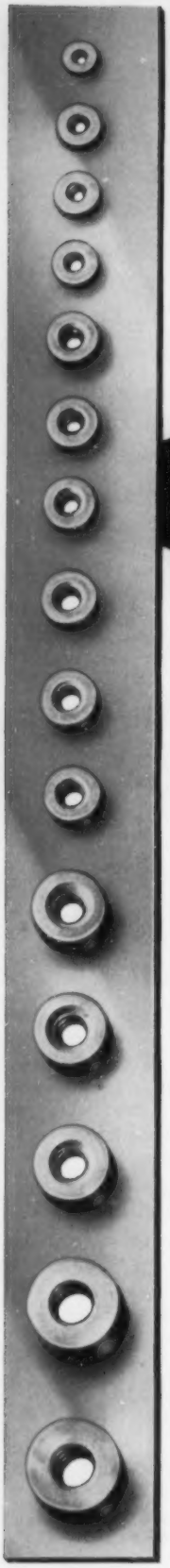

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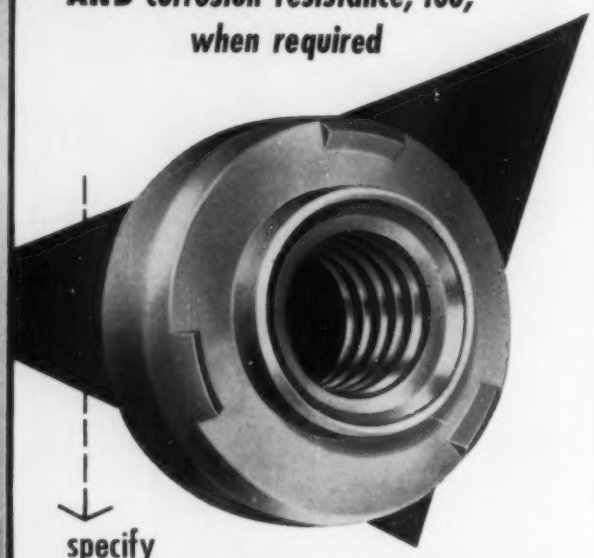

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Los Angeles—Bradshaw 2-8097
Miami—Tuxedo 5-3147

INDEX TO ADVERTISERS

(Continued from p. 167)

General Aniline & Film Corp., Ozalid Div. 134
General Electric Co., Apparatus Dept. 23
General Industries Co. 118
Globe Industries, Inc. 114
Goodrich Co., B. F., Aviation Products Div. 22
Goodrich Co., B. F., Industrial Products Div. 155
Grace & Co., W. R., Polymer Chemicals Div. 102-103
Gries Reproducer Corp. 161

Handy & Harman 170
Hannifin Co., Parker-Hannifin Corp. . 113
Hart Mfg. Co. 103
Heyman Mfg. Co. 157
Hilliard Corp. 144
Hitchiner Mfg. Co., Inc. 159
Howard Industries, Inc. 8-9
Huck Mfg. Co. 106
Hunter Spring Corp. 108

Imperial Tracing Cloth 156
Industrial Timer Corp. 145
International Nickel Co., Inc. 2

Jarvis & Jarvis, Inc. 158
Jones & Laughlin Steel Corp., Stainless & Strip Div. 129

Kennametal, Inc. 164
Keuffel & Esser Co. 143

Lamb Electric Co. 105
Leach & Garner Co. 157
Lead Industries Association 130
Leland, Inc., G. H. 124
Link-Belt Co. 11, 61

M-D Blowers, Inc., Subs. of Miehle-Goss-Dexter, Inc. 167
Mahon Co., R. C. 89
Merriman Brothers, Inc., Lubrite Div. 161
Metal & Thermit Corp. 104
Metals & Controls, A Div. of Texas Instruments, Incorporated 30, 46
Milford Rivet & Machine Co. 163
Miller Fluid Power Div., Flick-Reedy Corp. 117
Milsco Mfg. Co. 148
Miniature Precision Bearings, Inc. ... 140
Minnesota Mining & Mfg. Co. 52
Mobay Chemical Co. 96
Mt. Vernon Die Casting Corp. 120

National Machine Products Co. 154
National Tube Div., U. S. Steel Corp. . 14
Norgren Co., C. A. 137

Orange Roller Bearing Co., Inc. 123

Palnut Co. 165
Parker Hannifin Corp., Hannifin Co. ... 113
Parker-Hartford Corp. 156
Parker-Kalon Div., General American Transportation Corp. ..62-63
Parker Rust Proof Co. 58-59
Penn Engineering & Mfg. Corp. 168
Perkins Machine & Gear Co. 169
Philadelphia Gear Corp. 16
Porter Co., Inc., H. K., Riverside-Metal Alloy Div. 92
PresSure Products Co., Inc. 147
Protective Closures Co., Inc. 99

INDEX TO ADVERTISERS

Raybestos-Manhattan, Inc., Manhatan Rubber Div. 126-127
Raybestos-Manhattan, Inc., Packing Div. 126-127
Raybestos-Manhattan, Inc., Plastic Products Div. 126-127
Reliance Electric & Engineering Co. ..... 3rd Cover
Riverside-Alloy Metal Div., H. K. Porter Co., Inc. 92
Robbins & Myers, Inc. 31
Robertshaw Thermostat Div., Robertshaw-Fulton Controls Co. ... 26
Rockford Clutch Div., Borg-Warner Corp. 100
Ross Operating Valve Co. 1

SKF Industries, Inc. 138
Security Plastics, Inc. 146
Shell Oil Co. 135
Sinko Mfg. & Tool Co. 154
Square D Co. 15
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 60

Thiokol Chemical Corp. 139
Timken Roller Bearing Co. ..... 4th Cover
Tinnerman Products, Inc. 64
Titeflex, Inc. 121
Tomkins-Johnson Co. 119
Torrington Mfg. Co. 107

U. S. Gasket Co., Subs., Garlock Packing Co. 115
U. S. Rubber Co., Mechanical Goods Div. 94
U. S. Rubber Co., Naugatuck Chemical Div. 56-57
U. S. Testing Co. 122

Viking Pump Co. 153

Wagner Electric Corp. 43-44
Waldes Kohinoor, Inc. 17
Warner Electric Brake & Clutch Co. ... 116
Weckesser Co. 146
Westinghouse Air Brake Co., Industrial Products Div. 151
Wisconsin Motor Corp. 156

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F. J. Eberle, Business Mgr.
EMPLOYMENT OPPORTUNITIES 162
Index to Advertisers begins on P 167
Products Index begins on P 164

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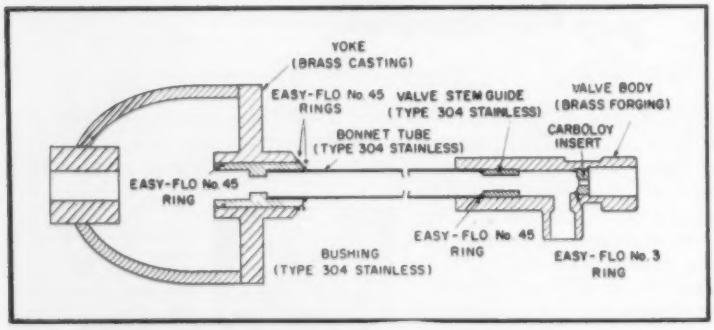

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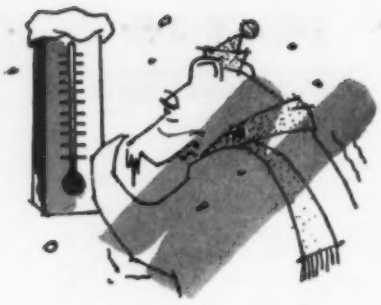

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1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

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FABRICATION PROCESSES AND PRODUCTION
308—Complex Extruded Teflon Shapes

POWER TRANSMISSION
309—Subminiature Duplex Clutch
331—Insulated Shaft Couplings

MECHANICAL PARTS
301—Shock and Vibration Isolator
306—All-metal Bellows Shaft Seal
321—Elapsed-time Counter

FASTENING AND JOINING
302—High-strength Locknut
304—One-piece Nylon Grommet
313—Semi-flexible Connector
324—Clinch-type Panel Fastener

MOTORS, ENGINES AND CONTROLS
328—Size 18 Servo Motor

ELECTRICAL ELECTRONIC COMPONENTS
311—High-temperature Potentiometer
315—Resistance Pressure Detector
317—Silicon Power Rectifier
319—Subminiature Elapsed Time Indicator
320—10-key Keyboard
322—Electric Cartridge Heater
323—Multipurpose Dual Connectors
327—Silicon Printed Circuit Rectifier Assemblies
330—Force Ring Transducer

HYDRAULIC, PNEUMATIC EQUIPMENT
300—High-pressure Connector
303—Pressure-controlled Valve
305—Centrifugal Air Blower
307—Combination Filter-solenoid
310—Air Hand-control Valve
312—Synthetic Grease
314—Separator-Regulator-Lubricator Unit
316—Pipe-less Relief Valve
318—4-way Air Valve
326—Pressure Control Valves
332—Data Processor

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1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
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11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
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16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	28	300						

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E84	E86	E88	E89	E90	E91	E92	E93	E94	E95
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18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
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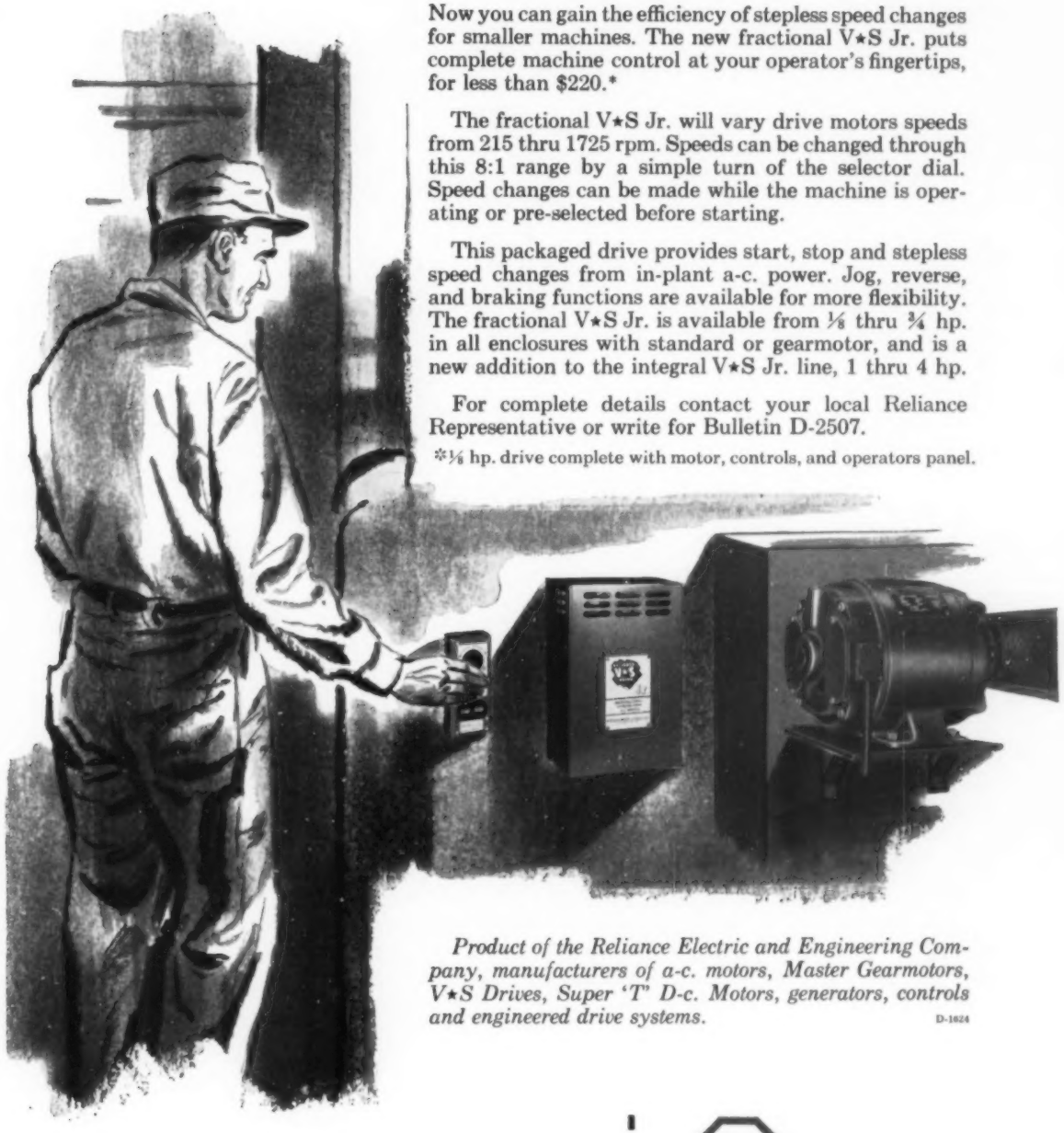

Now you can gain the efficiency of stepless speed changes for smaller machines. The new fractional V★S Jr. puts complete machine control at your operator's fingertips, for less than $220.*

The fractional V★S Jr. will vary drive motors speeds from 215 thru 1725 rpm. Speeds can be changed through this 8:1 range by a simple turn of the selector dial. Speed changes can be made while the machine is operating or pre-selected before starting.

This packaged drive provides start, stop and stepless speed changes from in-plant a-c. power. Jog, reverse, and braking functions are available for more flexibility. The fractional V★S Jr. is available from ⅛ thru ¾ hp. in all enclosures with standard or gearmotor, and is a new addition to the integral V★S Jr. line, 1 thru 4 hp.

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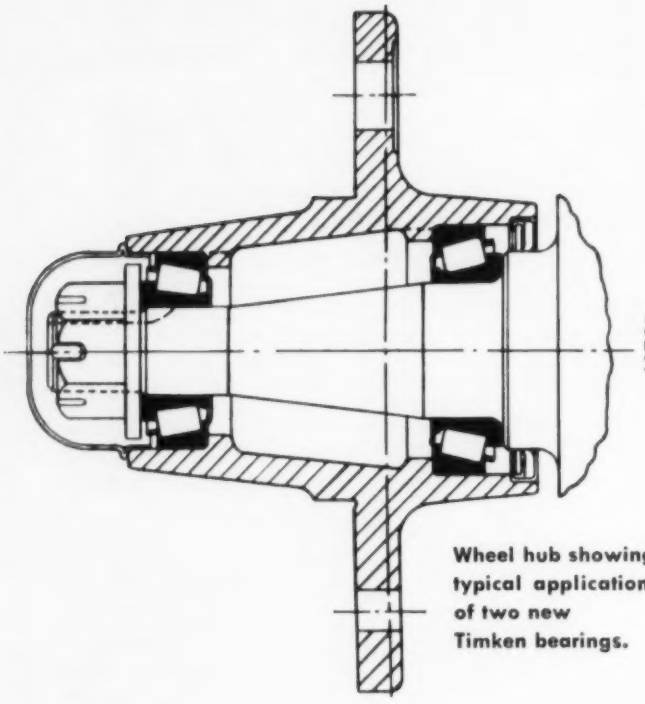
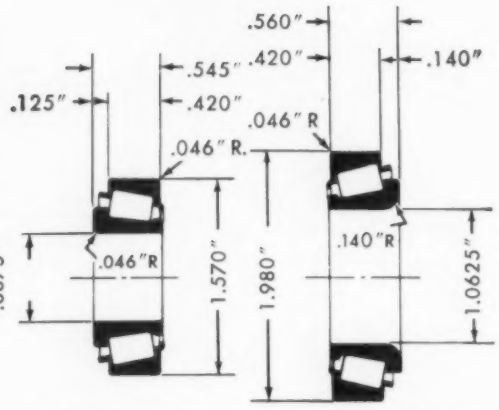
Three new, low-cost TIMKEN® bearings open new design opportunities



Wheel hub showing typical application of two new Timken bearings.



LM 11749—LM 11710
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L 44649—L 44610
Wt. .256 lb.

ALSO L44643
SAME AS ABOVE
EXCEPT WITH 1" BORE
Wt. .276 lb.

WITH three new small size Timken® bearings, machine designers can now get the advantages of tapered roller bearings where they couldn't be used before. These new, smaller bearings pack high capacity in less space, and they're lower in cost. They permit more compact designs by keeping related parts smaller—provide additional savings in hub materials, seals, nuts and dust caps.

Diagram above at left shows two of them in a typical layout of a front wheel hub for the Automotive Industry's new compact cars. They're the most economical single-row Timken bearings ever produced in bore sizes of 11/16", 1" and 1 1/16". Diagram above at right shows principal dimensions and weights.

Like all Timken bearings, these new Timken tapered roller bearings are geometrically designed and precision-made to roll true. Their taper lets them take *both* radial and thrust loads in any combination. And full-line contact between rollers and races provides extra load-carrying capacity.

Our Sales Engineers will gladly give you complete data, help you design the new bearings into your machines. Timken bearings make any machine better, because Betterness rolls on Timken tapered roller bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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